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Physical Activity and Game Play Ability in a High School Sport Education Basketball Season

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Abstract To date, there is limited research investigating physical activity levels during a sport education season in high school physical education settings and how these are affected by ability levels. The aim of this study was to investigate (1) how students' game play in basketball would improve during a sport education season as a function of ability level, and (2) how students' MVPA levels differ as a function of game play ability. One class with 21 high school students (aged 16-18) participated in a 14-day sport education basketball season. Prior to and upon completion of the season, students' 3v3 basketball game play performance was assessed. Three mixed ability teams were composed with an equal gender distribution. The System of Observing Fitness Instruction Time (SOFIT) was used to collect students' MVPA during the season. Repeated measures ANOVA detected a significant improvement in game play ability from 52% (range: 28%-68%) to 84% (range: 60%-100%) for high– as well as low-ability students, $p < .001$. High-ability students engaged in MVPA for 65% during team practice and 49% during game play. Low-ability students had consistently lower MVPA values than high-ability students (41% vs 55%), $p < .01$, with 56% of MVPA during team practice and 34% during game play. All students spent more than 40% of team practice and game play in vigorous physical activity. We concluded that both high-and low-ability high school students improved their game play and their ability level affected MVPA levels during the sport education basketball season. High-ability students met the 50% MVPA benchmark during team practice and game play, whereas low-ability students only met this guideline during team practice.

Keywords Skill Level, SOFIT, MVPA, Small-Sided Games, Physical Education

1. Introduction

It is generally accepted that high-quality physical education lessons engage children in moderate-to-vigorous physical activity (MVPA) for at least 50% of class time [1]. MVPA consists of activities between 3.0 and 5.9 (moderate physical activity) or above 6.0 (vigorous physical activity) metabolic units of energy expenditure [2]. In general, MVPA is generated by activities that require an energy consumption which is equal to or above an ordinary walk [3]. Differentiating between moderate and vigorous physical activity is important, since vigorous physical activity leads to different health outcomes compared to moderate physical activity, such as improved cardiorespiratory fitness and muscular strength [4]. The emphasis on physical activity in physical education is relatively recent and grounded in the effect physical activity has on health and disease prevention in youth, cognitively and physically [5,6]. Physical activity during physical education classes is important not only because of its health implications but also because children cannot become physically skilled or fit when they do not engage

actively [7]. A substantial body of literature demonstrates the positive relationship between motor engagement in subject matter and student learning (for a review [8]).

Research has shown that the 50% MVPA-benchmark is often not reached in elementary [9,10,11,12], middle [13,14,15,16,17] and high school [18] physical education classes. In their review of 40 studies with middle and high school students, Fairclough and Stratton [14] reported MVPA levels between 27% and 47% of lesson time. A more recent review including 25 studies reported average MVPA levels of 40.5%, with 48.6% for middle school students and 35.9% for high school students [19]. Important consideration here is that those reviews contain observational as well as experimental studies were successful in increasing MVPA levels during physical education and thus combining data from both types of studies should be done with caution. For the teaching of sport games, sport pedagogy literature has consistently reported concerns regarding low levels of students' physical activity in handball, soccer, volleyball, and basketball [13,18]. Also, the importance of the instructional model used by the teacher for achieving the 50% MVPA recommendation has been highlighted [20]. Direct instruction as an instructional model is considered to produce high levels of student inactivity, especially due to a large amount of teacher management time, an emphasis on skill and drill practices and the use of full sided games such as 11v11 in soccer [21]. In contrast, game-based models have been put forward to produce high levels of student physical activity [22]. Although these models are mainly student-centered approaches, Metzler [23] highlights the necessary active role of the teacher in learning processes during such student-centered classes. In these game-based approaches, small-sided games are used to align the learning environment with the real game which offers an authentic and quality learning experience [24,25]. It is authentic since skills are not learned in isolation but *in* the game, and it is a quality learning experience because with fewer players in a game, individual participation is increased [25]. Students can learn game-needed skills and understand principles of the game, aiming for a qualitative connection between the selection of skills and game situations [26]. In a study with middle school students, students' MVPA during a game-based approach for hockey reached 47% [27]. Another study with middle school students was able to demonstrate MVPA levels above 50% during a soccer unit using game-based approaches [28]. When interpreting MVPA levels the nature of the sport should be taken into consideration with invasion games leading to higher levels of MVPA compared to net-and wall games [14,29,30]. In the present study, high school students' MVPA was analyzed during a sport education season in basketball.

Sport education is a curricular model that provides students authentic sport experiences with respect to the heterogeneity in physical education classes [31]. The goals of this model are to develop students as competent (i.e., possessing essential skills to participate in games), literate (i.e., knowing the rules and values), and enthusiastic (i.e., enjoyment of the activity) players [31]. During a sport education season, students are put in fixed heterogeneous teams and engage in team practices and formal competitions against other teams [31]. Studies describing students' physical activity during a sport education season are limited, especially with high school students [32]. Hastie and Trost [33] found that in a sport education hockey season with middle school children, MVPA levels averaged 63.2% of lesson time. High skilled children had higher MVPA levels than low skilled children (66.8 vs. 60.8%), but this difference was not significant. Middle school children in the study by Parker and Curtner-Smith [34] with preservice teachers did not spend 50% of lesson time in MVPA. An elementary sport education fitness season showed that students spent an average of 54.5% of lesson time in MVPA [35]. One study conducted in a sport education fitness season with high school students found MVPA levels of 60.5% as measured by accelerometers [36]. To date, no research studied the MVPA levels of high school students during a sport education invasion games season as a function of game play ability, to evidence that the sport education model considers the heterogeneity (i.e., game play ability differences with students) within high school physical education classes. Hastie [37] has described the evidence for competence development as 'burgeoning and developing' and researchers have recommended further research exploring how students interact with the design of game-based tasks in sport education [38]. Only recently experimental research has been initiated investigating the differential effects of sport education across different skill groups in high school [39] and middle school [40,41]. Together these studies demonstrated larger improvements for children of all skill levels compared to a direct instruction model.

Additionally, this study wants to investigate how moderate and vigorous PA vary between high- and low-ability students in a sport education basketball unit. In a game-based soccer unit, Harvey et al. [28] analyzed vigorous physical activity (VPA) and how much of MVPA consisted of VPA. They found percentages VPA to MVPA-values ranging from 24% to 35%. Using small-sided games, Gabbett et al. [42] reported more opportunities to be vigorously active, more opportunities for skill trials and therefore a greater chance to have large learning effect. This indicated the importance of not only MVPA, but VPA, where there is a greater opportunity for learning.

This study wants to contribute to the literature in sport education by investigating students' physical activity as a function of ability level during a basketball season in high school. We defined two research questions, namely (1) how does students' game play in basketball improve during a sport education season as a function of ability level?, and (2) how does students' MVPA differ as a function of game play ability? We hypothesized that (1) students would

improve their 3v3 game play performance after the sport education basketball season, and that (2) no differences would be found in MVPA values between high -and low-ability students.

2. Methods

Setting and Participants

One high school class comprising 21 students (7 girls, 14 boys, mean age = 17 years) from a large urban school in Flanders (Belgium) participated in this study as a convenience sample. Students came from middle-to-high income households. Students received a 14-day sport education basketball season. They were not familiar with the instructional model but were taught basketball earlier in their school curriculum. Basketball is a content domain taught in most schools in Flanders. The teacher was 46 years of age, male, had 22 years of experience in teaching physical education, and was experienced in teaching the sport education model. All lessons had a scheduled time of 50 minutes and took place in the school's polyvalent sports hall consisting of three basketball courts. To be included in this study all students and their parents, the teacher, and the principal had to agree that all lessons would be videotaped. Approval for the study was given by the institutional review board of the first author's university.

Target Behavior

3v3 Game Play Ability. 3v3 game play ability was assessed in lesson one and 14 based on video recordings using a modified version of the basketball game play assessment tool [28]. During this assessment, students played 3v3 for a duration of seven minutes on a half court. Team compositions were the same at pre- and posttest. Each assessment, a total of five items were assessed with either 1 (struggling), 3 (developing) or 5 (competent), namely support, decision-making, transition play, guard/mark, and on-the-ball play. For all students, an individual game play score was calculated ranging between five and 25. Students with a game play ability score below the median of the class were labeled as low ability students, students above the median score were labeled as high ability students. The 3v3 small-sided version of basketball was chosen based on previous literature indicating 3v3 a good size to improve game play in this content domain [43].

Physical Activity. Every lesson, two students (one high- and one low ability student) of every team were randomly selected as a representative sample for physical activity observation during the team practice and game play lesson segments. Physical activity was assessed based on video recordings using the System of Observing Fitness Instruction Time (SOFIT), a reliable and valid instrument for assessing physical activity, lesson contexts and teacher behavior in physical education through systematic observation [44]. The SOFIT instrument has been used previously for assessing physical activity levels in game play [28,45] In this study, lesson context and teacher behavior was not coded. Momentary time sampling, using a 6-second observes and 6-second interval was used. During the "observe" interval, behavior of the target student was continuously observed. On the "record" prompt the level of physical activity was coded as either 1 (lying), 2 (sitting), 3 (standing), 4 (walking) or 5 (vigorous). Categories 1, 2 and 3 combined formed the sedentary variable, while categories 4 and 5 formed the moderate-to-vigorous physical activity (MVPA) variable. The total lesson time observed was 360 minutes and 16 seconds.

Sport Education Basketball Season

At the beginning of the first lesson students were organized in three fixed heterogeneous teams with an equal male to female ratio (n= 6-7). The teams were composed by their teacher based on previous physical education assessments and experience in teaching these students. All lessons had a standardized format with a duration of 50 min and included a team warm-up (10 min), (within) team skill practice (15 min) and game play (i.e., formal competition) (15 min). The remaining time was used for management and changing. All game play consisted of small-sided games with a maximum of 3v3 to modified rules. The themes of each lesson are described in Table 1. A total of 14 lessons were delivered to the students.

Sport education is a comprehensive instructional model with specific features to develop students as literate, competent and enthusiastic players [31]. An overview of the sport education features and how these were applied in this study are listed in Table 2. Students experienced participation in different roles throughout the season on a rotating basis and the formal competition schedule ensured equitable participation of all students. During game play, a competition was organized between the three teams. This event, usually a 3v3, took place in the second half of every lesson. The last lesson, a culminating 3v3 event was organized. During each lesson, at least two authors of the study were present to check implementation of the sport education model. No violations were observed.

Table 1. Overview of the Basketball Sport Education Season

	Theme
Lesson 1+2	Introduction of Sport Education model in basketball and pretest assessment of 3v3 game play ability.
Lesson 3+4*	Creating shot chances Shot selection
Lesson 5+6*	Spacing Individual defense.
Lesson 7+8*	Spacing variations.
Lesson 9+10*	Give and go Fill the spot.
Lesson 11+12*	Spacing Give and go Fill the spot One-on-one defense
Lesson 13+14	Culminating event and posttest assessment of 3v3 game play ability.

* Includes a 3v3 competition game.

Table 2. Sport Education Implementation Fidelity.

Features	Implementation
Units are longer than the typical PE units	The unit was extended to a 14-day season.
Students are organized into mixed ability teams throughout the season	Students were organized in fixed teams taking into account an equal male to female ratio in each team. Teams were composed heterogeneously based on previous motor skills test. One basketball field was assigned to each team.
Students executed several roles	Every two lessons, students switched roles.
All students have the opportunity to learn and be successful	Exercises were executed within the team, with a clear managerial instruction and adaptations for stronger or weaker students. Small-sided games (3v3) were organized.
Students are gradually introduced to the techniques and tactics of the activity	Tasks became more complex over the season. Teacher communicated clear expectations with the team coach.
Season consists of several competitions	Between teams: 3v3 games were played during the game play segment. Within teams: team activities with one or more defenders.
Organizational format for competitions	Two teams competed, one team practiced the 3v3 game play.
Records of performances are kept and made public	Every lesson, team performances were communicated to the class. During the game play segment, the score of the game was shown on a scoreboard.
Season champions are determined by a point system	Teams received points when: Student coaches fulfilled their tasks. They executed their duties as communicated by the teacher. They won a game during the game play segment.
Season is designed to be festive with a culminating event	Teams started every game with handshakes, as an element of fair play. High fives were made when the team scored a point. The last lesson of the season, a culminating 3v3 event was organized and prizes were awarded.

Observer training

Four observers with a background in physical education and basketball analyzed the data in this study. Observer training consisted of three steps. First, observers had to become familiar with the dependent variables related to physical activity and game play ability using a coding manual. Observers had to obtain a 100% score on a written test questioning their knowledge of definitions and codes. Second, observers received a written test in which they had to code 30 cases on physical activity for which they had to achieve a score of at least 85%. For game play ability, observers practiced coding in two 15-min 3v3 game play fragments from another research study for which they also had to achieve an 85% agreement with the criterion scores. Third, observers coded a criterion video for physical activity on which the observers reached an accuracy of 85% or more after which they could start coding the data from this study.

Data Collection

All variables were assessed based on video recordings of all lessons, using one camera per team. The observation started when the first exercise during the team practice segment was organized and ended when the last game during the game play segment was finished. At least two researchers supervised each lesson to ensure all cameras were recording and to check implementation fidelity of the

sport education season.

Data Analysis

The study was a one group pretest-posttest research design. One student was excluded from analysis, due to not taking the 3v3 game play ability pretest. Data were analyzed from 20 students (six girls, 14 boys). At the beginning of every lesson, two students per team were randomly selected for observation. Because of randomization, some students were observed two times. Therefore, 16 students in total were observed and consisted of high (n = 8) and low ability (n = 8) students. Observation and coding were performed by at least two trained observers of a research team experienced in 3v3 basketball. Analysis of variance (ANOVA) was conducted to analyze differences between teams, and high- and low-ability students. Repeated ANOVA was used to investigate basketball game play improvement from pretest to posttest. All data were analyzed using Statistical Package for the Social Sciences (IBM SPSS Statistics 24). Kolgomorov-Smirnov testing showed no violations in the assumptions of normal distribution ($p > .05$). The significance level was set at $p < .05$, and effect sizes were reported by means of partial eta squared values (ηp^2).

3. Results

Observation Reliability

All reliabilities were calculated using the following formula: (agreements/(agreements + disagreements))*100. Interrater reliability for physical activity was based on 33% of all observations as recommended for behavioral research [46]. Game play ability of all students was assessed by two trained coders and reliability was 84%.

3v3 Game Play Ability

Repeated measures ANOVA with time and ability level as factors showed significant improvement in 3v3 game play ability from pretest to posttest for all students, $F(1, 18) = 137.16$, $p < .001$, $\eta p^2 = .88$ [1]. Mean score at pretest was 12.90 (52%) and 20.90 (84%) at posttest. A significant difference was observed between high-ability and low-ability students, $F(1, 18) = 22.73$, $p < .001$, $\eta p^2 = .56$. No interactions effects were found. Low-ability students improved their average score from 8.71 (35%) to 18.43 (74%) and high-ability students from 15.15 (61%) to 22.23 (89%). No differences between teams were observed at pretest and posttest.

Moderate-to-Vigorous Physical Activity

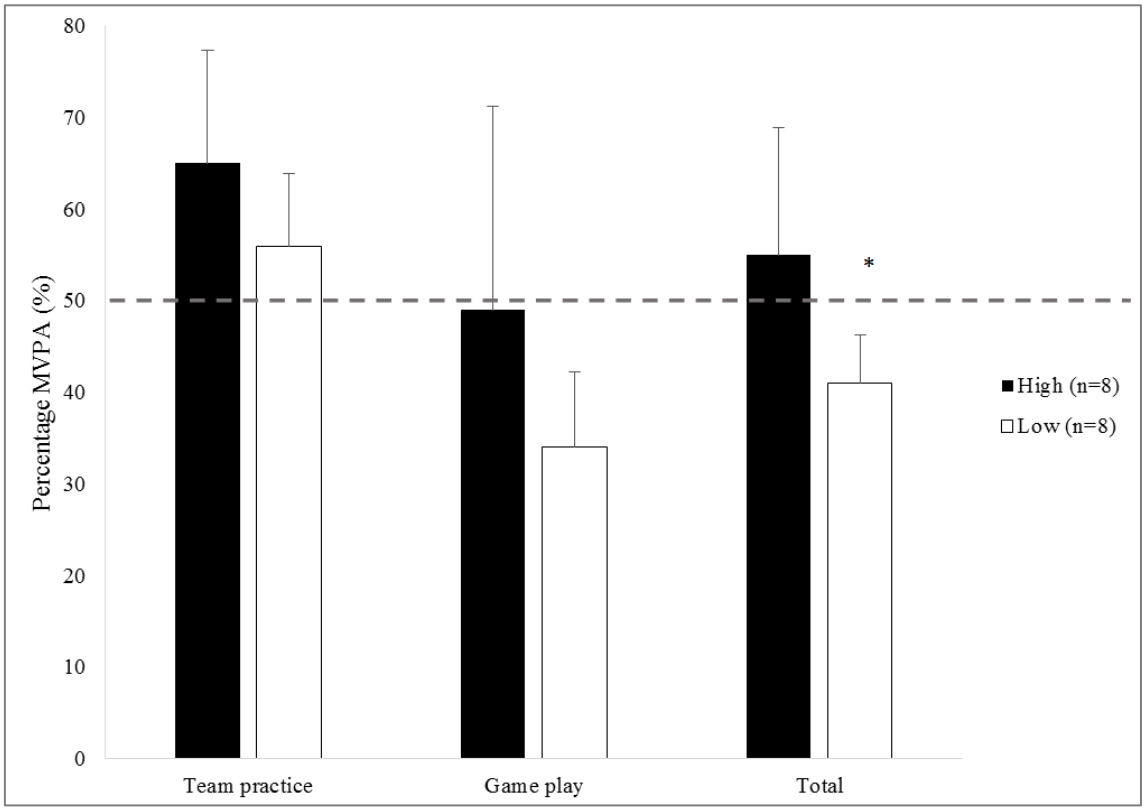
No significant differences were found for MVPA between high- and low- ability students during the team practice segment (65% vs 56%), nor during the game play segment (49% vs 34%). A significant difference between high- and low-ability players was found for game play and team practice MVPA combined (55% vs 41%), $F(1, 14) = 7.05$, $p = .019$, $\eta p^2 = .34$[1]. Low-ability players only reached the benchmark of 50% MVPA during team practice whereas high ability players' MVPA passed 50% during team practice and the average of both lesson segments (Figure 1).

Table 3 shows the mean percentage of vigorous physical activity (VPA) and the mean percentage of VPA to MVPA. Descriptive statistics showed that high-ability students have higher VPA during team practice (27% vs. 23%), game play (23% vs. 14%), and for the total of the lesson (24% vs. 17%). The proportion of VPA to MVPA for high-ability students compared to low-ability students was similar during team practice (42% vs. 41%) but higher during game play and for the total of the lesson, respectively 47% vs. 41% and 44% vs. 41%.

1 Due to the small sample size (n < 30), non-parametric statistics would be recommended. We preferred parametric statistics because of the assumption of normality and the increase in power. The same significant *p*-values were found when using non-parametric tests.

Table 3. Mean Percentages of MVPA, VPA and VPA to MVPA for High- and Low-Ability Students During Team Practice and Game Play.

	High-ability students (n = 8) ***M***	**Low-ability students (n = 8)** ***M***
Team Practice		
MVPA (%)	65	56
VPA (%)	27	23
%VPA to MVPA	42	41
Game Play		
MVPA (%)	49	34
VPA (%)	23	14
%VPA to MVPA	47	41
Total of Lesson		
MVPA (%)	55	41
VPA (%)	24	17
%VPA to MVPA	44	41



* $p < .05$.

Figure 1. Mean Percentages and Standard Deviations of MVPA (%) as a Function of Game Play Ability during Team Practice and Game Play. Dashed Line indicates the 50% MVPA Recommendation.

4. Discussion

The aim of this study was to investigate (1) how students' game play in basketball would improve during a sport education season as a function of ability level, and (2) how students' MVPA levels would differ as a function of game play ability. First, the hypothesis that high school students would improve their 3v3 game play ability after the sport education basketball season was confirmed. This study is therefore in line with previous work indicating that sport education enhances game play performance [47,48,49]. Hastie [50] demonstrated significant improvement in game performance during a 30-lesson Ultimate Frisbee season. Subsequent studies demonstrated significant game play improvement in volleyball [48], mini volleyball [40], badminton [47], and basketball [49]. To date, limited

research has focused on student's initial ability level as a mediating factor on process variables such as physical activity and product variables like game play performance. In this study, both low-and high-ability students improved their game performance significantly with low-ability students on average reaching higher posttest scores (74%) than the high-ability students at pretest (61%). Hastie [50] was the first to investigate initial ability level of students in a sport education season and concluded that lower-ability students did not feel marginalized and believed they had equal opportunities for improvement because of the consistent team membership and sufficient length of the unit. Indeed, in traditional approaches for games teaching students might be put into different teams every lesson which allows the higher-ability players to dominate game play, leaving less learning opportunities for low-ability players. In addition, like in mixed-ability reciprocal peer learning settings, an 'expert-novice' relationship might have contributed to the learning effect of lower ability students in the sport education teams [51,52). In the study by Mahedero et al. [40] it was reported that because of the persisting teams, higher-ability students made deliberate efforts to help their lower-ability peers to improve the performance of the team. A later study by Araújo et al. [53] found that low-ability students realized greater gains than high-ability students during a sport education-Step-Game approach in volleyball with primary school students. The average basketball performance of the low-ability students in the present study improved by 39% whereas high-ability students improved on average 28%. Important to note is that game play was measured using the cumulated scores on five variables, namely support, decision-making, transition play, guard/mark, and on-the-ball play. All five variables had an equal weight and added to a total score on 25, and were then converted into a percentage. Previous studies often used indexes such as the 'decision making index' (DMI) based on the Game Performance Assessment Instrument (GPAI) [53] (see for example [40,49]).

The second hypothesis, which stated that no differences would be found in MVPA between high- and low-ability students, could not be confirmed. High-ability students had on average significantly higher levels of MVPA than low-ability students (55% vs 41%). Research in elementary, middle and high school PE generally concluded that students do not reach the 50% MVPA-benchmark unless there is a planned focus on physical activity (for reviews see [14,30,55]). Sport education addresses the issue of students' inactivity because a substantial part of each lesson is dedicated to between and within teams competition, putting the focus on playing the game. Game play in sport education is characterized by playing small-sided games to modified rules, two factors crucial for increasing activity and individual learning opportunities [50]. Several studies indeed showed that students reach higher levels of physical activity in a sport education setting and more importantly, reach the 50% MVPA-benchmark [33,35,36]. Therefore, the sport education model for teaching sport games might be effective for skill development and improving game play ability while in the meantime engaging children in 50% of MVPA, a situation referred as 'two sides of the same coin' [28].

Hastie and Trost [33] found no differences in MVPA between high- and low-skilled students during a floor hockey sport education season, findings that were confirmed by Hastie and Sinelnikov [56] in basketball. In our study, low-ability students had consistently lower MVPA levels with 56% of MVPA during team practice and 34% during game play. High-ability students reached 65% of MVPA during skill practice and 49% during game play. Possibly, low-ability students acted as competent bystanders. A competent bystander is a student who is very competent in avoiding teacher-assigned tasks without drawing the teacher's attention to his or her inactivity [57]. During basketball team practice, the competent bystander might allow other students extra practice while skillfully avoiding practicing him- or herself by waiting longer in line. During game play, the competent bystander might have cruised up and down the court but somehow managed to stay away from being engaged with the ball [57]. Despite the persisting teams and the limited team size low-ability students might not have equal opportunities compared to their high-ability counterparts. During game play for example, low-ability students perhaps lacked knowledge to move into open spaces and receive passes, which could have accounted for lower levels of MVPA. Finally, in the study of Parker and Curtner-Smith [34] in which pre-service teachers taught a sport education mini-soccer season to middle school students, students did not achieve the 50% benchmark. As a possible reason for not reaching this benchmark, the authors put forward the inexperience of the pre-service teachers. In our study however, the teacher had 22 years of experience in basketball.

Harvey et al. [28] reported percentages of VPA to MVPA between 24% and 35% in soccer while we reported percentages between 41% and 47%. Both soccer and basketball are invasion games, which are considered to generate high levels of MVPA and VPA due to the activation of large muscle groups, especially when taught using small-sided games in smaller field/court areas. Harvey et al. [28] did not report the team sizes during their small-sided soccer games so we recommend future work to do so in order to interpret findings. In addition, their levels of MVPA and VPA were based on the total lesson whereas we reported only on the team practice and game play segments.

This study has some limitations. First, it was a study conducted using a practice-referenced research design. A practice-referenced approach is an alternative for research that compares a certain instructional model such as sport education with another instructional model like direct instruction [58]. According to Kirk [58], a

practice-referenced approach is concerned with investigating the usefulness of the model itself in terms of learning and the context in which it has been applied. As such, we could not make comparisons with a control or comparison group to provide additional efficacy for the sport education model in terms of the investigated variables. However, due to the repeated measures design we could provide evidence for learning with implementation of the sport education model. Second, the teacher in this study was experienced in basketball and the sport education model. Therefore, results from this study should be interpreted keeping in mind the possible positive bias due to the experienced teacher. Third, due to contextual reasons, we provided a 14-day sport education unit. Previously, Siedentop et al. [31] recommended seasons that last about 18 to 20 sessions, which are typically longer than usual physical education classes. The main reasons are the increase in opportunities to learn and organization preparation time. Therefore, as we provided a 14-day season, this could be a reason why low ability students did not reach the 50% MVPA benchmark. However, even though this season was shorter in the number of sessions than the sport education recommendations, the total minutes in sport education was high due to the session length of 45 minutes and both high and low ability students improved their 3v3 game play ability. Fourth, results from this study should be replicated in other high school settings to investigate generalizability.

Lastly, we are aware that the design of this study can also be a limitation. Only a pre-test and a post-test was conducted with the students, which means that no retention test was applied. It is possible that the students' learning effects are even more significant than it has been shown in this study. Further investigations about the learning effects in the long term of high and low ability students are needed.

This study adds to the sport education literature in several ways. First, it is among the first to investigate physical activity as a function of ability level in a high school sport education season. To date, physical activity levels during sport education units in high school settings have rarely been investigated [36]. We collected MVPA through direct observation using the SOFIT-protocol in two lesson segments separately, namely team practice and game play. In doing so, we provided a more detailed account of the differential effects of those segments on high- and low-ability students' physical activity. Consequently, this research responds to the call for investigation of the differential effects sport education has on students of different skill levels [38]. Second, this study contributes to the use of small-sided games in a basketball season. Ward et al. [43] recommended the implementation of 3v3 for basketball because it is a good size for improving game play. Results from this study provide support for this recommendation. In addition, repeated measures analysis showed no interaction effect meaning that both low-and high-ability students equally improved their game play. Third, except for low-ability students during game play, results from this study showed that students can reach high levels of MVPA while at the same time improving their game play ability.

5. Conclusions

Based upon the results from this study, it can be concluded that although low-and high ability students significantly improved their 3v3 game play in basketball, they had significantly different levels of MVPA. Especially during game play, MVPA differences between high- and low ability students were the largest. High-ability students consistently engaged in 50% of MVPA whereas low-ability students only met this guideline during skill practice. Replication studies are necessary to investigate how to increase MVPA levels of low-ability students, especially during game play segments, while at the same time increasing their performance.

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