

Basic Research on Developing Methods for Teaching and Evaluating Off-Ball Movement in Elementary Physical Education Soccer: A Comparison of Game Performance with Regional Soccer Club

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Abstract

In upper elementary school physical education, the primary focus of ball games is on teaching students how to play offense and defense in groups. However, there is a lack of consideration regarding how to teach and evaluate group movement. Therefore, the purpose of this study was to obtain data for the development of teaching and evaluation methods for off-the-ball group movement in elementary school soccer classes. In a soccer game, the occurrence rate of the Around Defender Diamond Shape (ADDS) formation, the passing success rate, and the number of players who could receive the ball were comparatively analyzed among three groups: 5th-grade students from H Elementary School (HS5 students), 4th-grade students from G Soccer Club (GC4 students), and 5th-grade students from G Soccer Club (GC5 students). The following results were observed: 1) The occurrence rate of the ADDS formation was significantly higher among GC4 students (52.5%) and GC5 students (56.3%) compared to HS5 students (27.8%). 2) The passing success rate was significantly higher among GC5 students (50.5%) compared to HS5 students (28.6%). 3) A significant difference was observed in the number of players who could receive the ball, with HS5 students exhibiting a higher occurrence rate (27.8%) of cases in which four players could receive the ball compared to GC4 students (15.1%). From the above, it can be inferred that off-ball group movement is a learnable tactical task for fourth and fifth grade elementary school students. Furthermore, there is a need for novel indicators for teaching and evaluating collaborative movement in groups. The ADDS formation may be one such indicator.

Keywords

Elementary School, Physical Education, Regional Club, Off-Ball Movement, Support, Around Defender Diamond Shape, Teaching Methods, Evaluation Methods

1. Introduction

In the past, ball game instruction in physical education (PE) classes used to emphasize technical instruction for ball manipulation (Griffin et al., 1999; Kondoh et al., 2008; Goto & Seya, 2010; Adachi et al., 2013). In some cases, technical skills were evaluated independently of the game, or instruction simply ended with students enjoying the game. Despite players attempting to move to appropriate positions for offense or defense, such aspects of game performance were rarely instructed in PE classes (Griffin et al., 1999). Since the 1980s, there has been a growing recognition of the importance of incorporating tactical training alongside technical training in educational curricula (Sato & Kondo, 2015). In recent years, there has been an increased emphasis on tactical training, which focuses on addressing tactical challenges (Souno & Sato, 2014). Okade (1998) argues that a focus on tactical training allows for the attribution of performance deficiencies to be shifted from innate talent to the outcomes of the learning process. Therefore, teachers are expected to possess the ability to teach and evaluate game performance aspects, including tactics.

In order for students to solve tactical problems and improve their game performance, their actions should encompass two aspects: technical skills, such as passing and shooting, and off-ball movements, such as support (Griffin et al., 1999; Ministry of Education, Culture, Sports, Science and Technology (MEXT), 2018). Among these, off-ball movements have been identified as particularly important for optimizing student game performance to its maximum. This is because the majority of actions in a game are off-ball movements, and for players in possession of the ball to effectively exhibit their passing skills, they require a supporting receiver (Griffin et al., 1999).

In a prior study on off-ball movements during ball games in PE classes, Goto & Seya (2010) developed and implemented a “task-oriented game” designed to facilitate supportive movements in soccer classes for sixth-grade elementary school students. Their findings indicated an increase in both the quantity and diversity of supportive actions. Similarly, Okade et al. (2000) reported an increase in the exploitation of space during offensive plays, where students learned to move into open spaces to provide support, after incorporating supportive movements into soccer classes for sixth-grade elementary school students. Adachi et al. (2013) developed and implemented a “ball-less game” to foster supportive behavior in middle school soccer and basketball classes. They reported that an enhancement in supportive skills was observed. Thus, numerous studies have focused on the

development of teaching materials that emphasize support (Keino & Sukou, 2020; Matsubara, 2023), which is a fundamental movement when a player does not possess the ball in soccer and other ball games.

However, these studies are concerned with individual movements. To the best of our knowledge, no study has objectively examined the instruction and evaluation of group movement in ball games, which are team sports. The “Commentary on the Curriculum Guidelines for Elementary Schools (Ministry of Education, Culture, Sports, Science and Technology (MEXT), 2018)” indicates that in the upper grades, students should learn to play offense and defense in groups. However, only a few suggestions are made regarding individual movements, such as “moving to prevent defenders from getting between the ball carrier and oneself” and “moving to a location where it is easier to score.” There is no mention of how multiple players can cooperate and move together without the ball. To enhance the learning outcomes of children and students, it is essential for teachers to provide verbal guidance and ask relevant questions, as well as create appropriate teaching materials (Japan Football Association (JFA), 2014). Adachi et al. (2013) emphasized the necessity of introducing effective teaching materials and providing opportunities to demonstrate support skills. They also stated that it was important for teachers to provide more explicit instruction and feedback regarding the positioning of effective support. Therefore, it would be beneficial to specifically examine players’ off-ball movements in groups during ball games played as part of PE classes. This would deepen students’ tactical understanding and clarify teachers’ perspectives on instruction and evaluation.

The present study focuses on soccer, a typical goal-oriented ball game that is also covered in the Commentary on the Curriculum Guidelines for Elementary Schools (Ministry of Education, Culture, Sports, Science and Technology (MEXT), 2018). Furthermore, among off-ball movements, we concentrate on support, which has the lowest level of tactical complexity (Griffin et al., 1999) and is considered a basic off-ball movement (Keino & Sukou, 2020; Matsubara, 2023) that should be learned first in group play. Additionally, Sato & Kondo (2015) highlighted the necessity of developing and verifying the educational content of soccer classes conducted as part of PE by incorporating new insights into the ever-evolving skills and tactics pertaining to top-level soccer.

In this research, we used the Around Defender Diamond Shape (ADDS) formation, which was suggested by Matsubara et al. (2022b) to be effective for group support play among players in Japan’s top soccer league, to analyze the movement of players in groups. We comparatively analyzed the occurrence rate of the ADDS formation, passing success rate, and the number of players who could receive the ball among three groups with different skill levels: fifth graders in elementary school PE classes, as well as fourth and fifth graders in a regional soccer club. The purpose of this study was to obtain data for developing teaching and evaluation methods for off-ball movement in group play during elementary PE soccer classes.

2. Methods

2.1. Object of This Study

A total of 43 games were included in the analysis conducted in this study: 19 games played as part of PE classes of fifth-grade students at H Elementary School, affiliated with O University (referred to as “HS5 students”) in December 2022, as well as 12 games played by the fourth-grade team (referred to as “GC4 students”) and 12 games played by the fifth-grade team (referred to as “GC5 students”) of G Soccer Club in March 2023. G Soccer Club is a popular regional youth soccer club. The elementary school and soccer club were selected for the survey because they were expected to provide representative information regarding the basic gameplay characteristics of children of this age at each institution.

2.2. Game Overview

A simplified game format of 5-on-5 was implemented, in accordance with the guidelines set forth in the Commentary on Curriculum Guidelines for Elementary Schools (Ministry of Education, Culture, Sports, Science and Technology (MEXT), 2018). Each team consisted of 5 players, with the dimensions of the court being 15 meters in width and 30 meters in length. The width of the goal was set at 5 meters (Figure 1). The duration of each game was 5 minutes.

2.3. Measurement Methods

A digital video camera, set up to provide a bird’s-eye view of the entire court, was utilized to record 5-on-5 games, enabling constant observation of the movements of all 10 players. The video data were subsequently analyzed to assess the presence or absence of pressure, diamond shape (DS) formation, and the number of players who could receive the ball. The methodology involved playing and pausing the video data for each target case using Hudl (manufactured by Hudl, Inc.). The measurements were performed by one of the authors. The definitions of pressure, DS, and ADDS; the criteria for the selection of cases to be measured; and the measurement items are elaborated upon below.

2.3.1. Pressure

We referred to the definition of pressure given by Tanaka (1986), which states, “pressure is the act of restricting the opponent’s offense, preventing them from passing the ball freely.” Thus, we defined pressure as the situation in which the defender is in a position to intervene in all of the ball carrier’s passing options and is therefore closer to the ball carrier than they are to the nearest allied player.

2.3.2. Diamond Shape

The definition of DS was based on that described by Matsubara et al. (2022a) and was defined as follows: any case wherein angles CAB, CAD, ACB, and ACD in quadrilateral ABCD, which is formed by connecting ball carrier A and three teammates (B, C, and D), are between 0° and 90° (Figure 2).

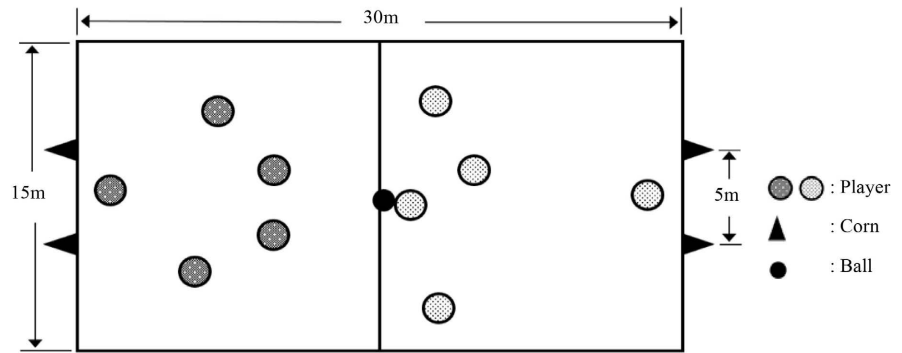


Figure 1. Overview of a 5-on-5 game.

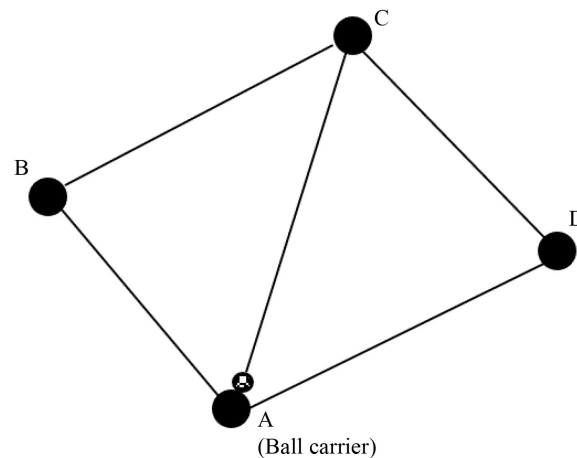


Figure 2. Diamond shape (Reproduced from Matsubara et al., 2022a).

To minimize errors in angle measurement from the video, we created a schematic diagram of the court based on those of sports courts used in descriptive analysis (Hughes, 2003). The positional information necessary for angle calculations was arranged on the schematic diagram of the court.

2.3.3. Around Defender Diamond Shape

Based on the definition formulated by Matsubara et al. (2022b), the present study defined ADDS as the DS formed around the first defender (1st DF) against the ball carrier in a pressure situation, as illustrated in Figure 3.

2.3.4. Criteria for the Selection of Cases for Measurement

The cases selected for measurement, as referenced from Matsubara et al. (2022a), consisted of those where a player received a pass from a teammate during an offensive phase while under pressure and made the first touch on the ball. Cases where a player received the final pass leading to a shot were excluded from measurement, as it was deemed that the players were not positioned in a typical arrangement for completing passes. Based on these criteria, a total of 497 cases were selected for measurement, including 126 cases involving HS5 students, 179 cases involving GC4 students, and 192 cases involving GC5 students.

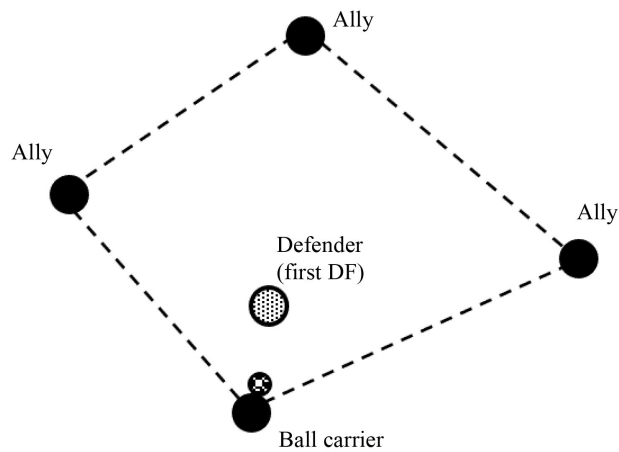


Figure 3. Around defender diamond shape (Reproduced from Matsubara et al., 2022b).

In terms of the criteria for classifying the phases of play, we referred to [Japan Football Association \(JFA\) \(2020\)](#) and divided them into four phases: offense, transition from offense to defense, defense, and transition from defense to offense. The onset of the offensive phase was determined by referencing [Suzuki et al. \(2019\)](#) and was defined as the moment when the ball was kicked during a set play or when, during in-play, the defending side touched the ball and possession switched sides, at which point either the first player touched the ball two times or the total number of touches between the first and second players was two.

2.4. Measurement Items

2.4.1. Occurrence Rate of ADDS Formation

In the cases selected for measurement, the presence or absence of the ADDS formation was assessed, and its occurrence rate was calculated. The occurrence rate of the ADDS formation was determined by dividing the number of cases with the ADDS formation by the total number of cases measured and multiplying by 100.

2.4.2. Occurrence Rate of Cases in Which a Certain Number of Players, Ranging from 0 to 4, Could Receive the Ball

In the cases selected for measurement, the number of players who could receive the ball was determined and the occurrence rate of cases in which a certain number of players, ranging from 0 to 4, could receive the ball was calculated. The occurrence rate was obtained by dividing the number of occurrences for each number of players by the total number of measured cases and multiplying by 100.

Regarding the criteria for measuring players who could receive the ball, [Tera-da \(2018\)](#) cited voice, gaze, gesture, movement, and being in a position conducive to passing as ways for receivers to request the ball. [Mitchell et al. \(2021\)](#) cited remaining in or moving to an appropriate position to receive a pass as a criterion for evaluating support. In this study, a non-ball carrier was considered

a player who is likely to receive the ball if the behavior at the moment of the ball carrier's first ball touch satisfied both of the following:

- 1) Gaze: Face towards the ball carrier.
- 2) Positioning: No defender between the player and the ball carrier.

2.4.3. Passing Success Rate

In the measured cases, the number of successful and unsuccessful passes were recorded and the passing success rate was calculated. The passing success rate is determined by dividing the number of successful passes by the total number of cases, and then multiplying by 100.

With respect to the definitions of successful and unsuccessful passes, a pass is considered successful if the ball, passed by the ball carrier, is received by a teammate without being touched by a defender. In all other instances, the pass is considered unsuccessful.

2.5. Methods of Statistical Analysis

2.5.1. Reliability

In order to assess the reliability of the measurement records obtained through play analysis, we evaluated the level of agreement between the records of two analysts. This evaluation was conducted with reference to the works of Yamada et al. (2010), Costa et al. (2010), and Suzuki et al. (2019). The same analysis was conducted on 50 cases and 261 players by an individual who had played and coached football and was engaged in scientific research on football, as well as by the author. The agreement rate ($=\text{number of agreements}/(\text{number of agreements} + \text{number of disagreements})$) was determined for each measurement item based on the analysis results of both individuals. The measurements were made separately, and the interpretation of the agreement rate values was based on Siedentop & Tannehill (1999).

2.5.2. Intergroup Comparison of the Occurrence Rate of the ADDS Formation, Passing Success Rate, and the Number of Players Who Could Receive the Ball

A z-test was performed to evaluate the differences between the three groups (HS5, GC4, and GC5 students) in terms of the occurrence rate of the ADDS formation, passing success rate, and the occurrence rate of cases in which a certain number of players, ranging from 0 to 4, could receive the ball. The Bonferroni method was utilized for back-testing. The level of significance for statistical tests was set at 5%.

3. Results

3.1. Agreement of the Measurement Records

As shown in Table 1, the agreement rate for each measurement record obtained through play analysis exceeded 90% for all items, indicating a satisfactory level of consistency among the records.

3.2. Occurrence Rate of the ADDS Formation and Passing Success Rate

Table 2 presents an intergroup comparison of the number of occurrences of the ADDS formation and its occurrence rate, as well as the number and rate of successful passes, for the three groups: HS5, GC4 and GC5 students.

The occurrence rate of the ADDS formation was significantly higher in GC4 students (52.5%) and GC5 students (56.3%) compared to HS5 students (27.8%) ($p < .05$). However, no significant difference was observed between GC4 and GC5 students.

In terms of passing success rate, GC5 students (50.5%) exhibited a significantly higher rate than HS5 students (28.6%) ($p < .05$). No significant differences were established between HS5 and GC4 students (39.7%) nor between GC4 and GC5 students.

3.3. Occurrence Rates of Cases in Which a Certain Number of Players, Ranging from 0 to 4, Could Receive the Ball

Table 3 and **Figure 4** present the results of an intergroup comparison among the three groups: HS5, GC4, and GC5 students. The comparison is based on the number of occurrences and the rate of occurrence of cases in which a certain number of players, ranging from 0 to 4, could receive the ball.

No significant differences were observed among the three groups in the occurrence rate of cases in which 0, 1, 2, and 3 players could receive the ball. Accordingly, the occurrence rates for HS5 students were 1.6%, 13.5%, 21.4%, and 35.7%, respectively. For GC4 students, the rates were 5.6%, 16.8%, 23.5%, and 39.1%, respectively. For GC5 students, the rates were 3.1%, 10.9%, 28.1%, and 40.1%, respectively. However, a significant difference was observed in the rate of occurrences of cases in which 4 players could receive the ball, with HS5 students exhibiting a significantly higher rate (27.8%) than GC4 students (15.1%) ($p < .05$).

Table 1. Agreement of measurement records.

Measurement items	Agreement rate
Presence/absence of ADDS formation	94%
Successful and unsuccessful passes	98%
Number of players who could receive the ball	92%

Table 2. Intergroup comparison of the occurrence rate of the ADDS formation and pass success rate.

	HS5 students		GC4 students		GC5 students		Difference
	Occurrences	Occurrence rate	Occurrences	Occurrence rate	Occurrences	Occurrence rate	
Cases	126		179		192		
ADDS	35	27.8% ^a	94	52.5% ^b	108	56.3% ^b	*a < b
Pass success rate	36	28.6% ^a	71	39.7%	97	50.5% ^b	*a < b

Note (1) Cases: Instances when the ball is passed in the offensive phase and received under pressure; Note (2) ADDS: Around Defender Diamond Shape; Note (3) * $p < .05$.

Table 3. Intergroup comparison of the occurrence rate of cases in which a certain number of players, ranging from 0 to 4, could receive the ball for each number of players.

	HS5 students		GC4 students		GC5 students		Difference
	Occurrences	Occurrence rate	Occurrences	Occurrence rate	Occurrences	Occurrence rate	
Cases	126		179		192		
0 players	2	1.6%	10	5.6%	6	3.1%	
1 player	17	13.5%	30	16.8%	21	10.9%	
2 players	27	21.4%	42	23.5%	54	28.1%	
3 players	45	35.7%	70	39.1%	77	40.1%	
4 players	35	27.8% ^a	27	15.1% ^b	34	17.7%	*a > b

Note (1) Cases: Instances when the ball is passed in the offensive phase and received under pressure; Note (2) * $p < .05$.

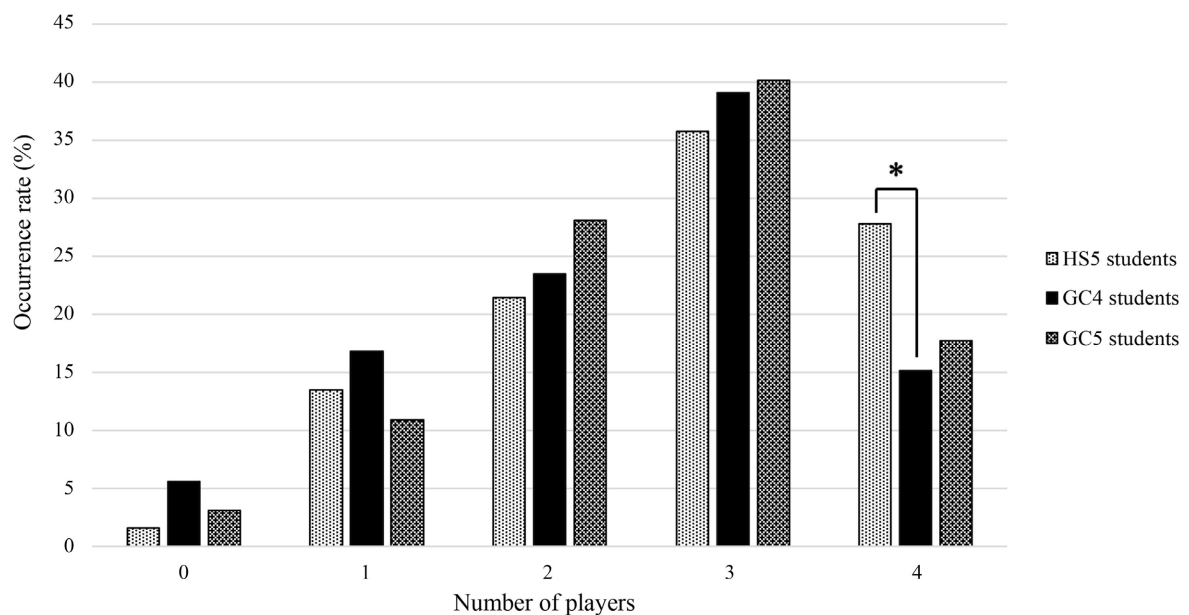


Figure 4. Intergroup comparison of the occurrence rate for each number of players who could receive the ball (* $p < .05$).

4. Discussion

The occurrence rate of the ADDS formation was found to be significantly higher in GC4 and GC5 students compared to HS5 students. In terms of passing success rate, GC5 students exhibited a significantly higher rate than HS5 students. Regarding the occurrence rate of cases in which a certain number of players (ranging from 0 to 4) could receive the ball, no significant difference was observed between the three groups for 0 to 3 players, and only in terms of the occurrence rate for 4 players, HS5 students exhibited a significantly higher rate than GC4 students. In other words, although the number of players who could receive the ball among HS5 students was not significantly different from or tended to be slightly higher than the other two groups, the occurrence rate of the ADDS formation among HS5 students was the lowest among the three groups and the passing success rate was also lower than that of GC5 students.

The development of play in children's soccer games has been shown to follow stages in the order of density, verticality, spread, activity, and adaptability, similar to the developmental path of soccer's evolution (Takii, 2003). Furthermore, it has been noted that, for advancing while retaining possession of the ball during a game, it is effective for players near the ball carrier to position themselves in a DS formation and coordinate their movements to receive the ball (Okada, 2019; Sakamoto, 2021; Matsubara et al., 2022b; Matsubara, 2023).

These findings suggest that GC5 and GC4 students were at a more advanced stage of play development than HS5 students. The GC5 and GC4 students were able to position themselves in an ADDS formation more frequently than the HS5 students, which might have contributed to their higher passing success rates. Thus, the findings indicate that off-ball group movement represents a learnable tactical task for 4th and 5th grade elementary school students.

The findings also indicate a need to reevaluate the teaching and evaluation methods for off-ball movement. The criterion employed in this study for determining players capable of receiving the ball, namely, the absence of a defender between the ball carrier and the players, has been utilized in numerous prior studies (Griffin et al., 1999; Higashikawa et al., 2007; Onizawa et al., 2008; Goto & Seya, 2010; Goto & Seya, 2011; Adachi et al., 2013; Keino & Sukou, 2020) and is recommended as an evaluative measure in PE classes, as outlined in the Commentary on the Curriculum Guidelines for Elementary Schools (Ministry of Education, Culture, Sports, Science and Technology (MEXT), 2018). However, the findings of this study suggest that this criterion alone may be insufficient for assessing the group game performance of upper elementary school students. There is a need for novel indicators for teaching and evaluating collaborative off-ball movement in groups. The ADDS formation may be one such indicator.

Game performance is exhibited through the integration of ball-manipulation techniques and off-ball movements. In this study, the direct influence of the ADDS formation on passing success rate was not investigated. It has been noted that, while movement patterns are effective as flexible agreements in ball games (Aida, 2006, 2016; Aida & Funaki, 2011; Tsuchida et al., 2001), it is necessary to adapt one's actions in response to those of the opponent and the current situation during the game (Aida, 2006). Additionally, Iwamasa (2021) asserts that optimal spatial relationships between players result from each player observing their opponents and teammates and executing movements deemed effective. Therefore, although it is significant that this study suggests that the ADDS formation has the potential to serve as an indicator for teaching and evaluating off-ball group movement, to apply these findings in instructional settings, it is necessary to further verify the effectiveness of the ADDS formation for game performance and investigate the specific ways in which it can be used.

5. Summary

The objective of this study was to obtain data for the development of teaching

and evaluation methods for off-ball group movement in elementary school soccer classes. The ADDS formation, suggested by Matsubara et al. (2022b) to be effective for analyzing group movement among top league soccer players in Japan, was employed to compare the occurrence rate of the ADDS formation in soccer games, passing success rate, and the number of players capable of receiving the ball among three groups with varying skill levels: HS5, GC4, and GC5 students. The findings of this study can be summarized as follows:

- The occurrence rate of the ADDS formation was found to be significantly higher among GC4 (52.5%) and GC5 (56.3%) students compared to HS5 students (27.8%).
- GC5 students (50.5%) exhibited a significantly higher passing success rate than HS5 students (28.6%).
- In terms of the occurrence rate of cases in which a certain number of players could receive the ball, no significant differences were observed between the three groups for 0 to 3 players. However, in terms of the occurrence rate for 4 players, HS5 students (27.8%) had a significantly higher occurrence rate than GC4 students (15.1%).

In conclusion, the findings of this study suggest that the GC5 and GC4 students may have increased their passing success rates by forming the ADDS more frequently, which is considered an effective formation for passing the ball to other players. As such, off-ball movement in groups is a learnable tactical task for 4th and 5th grade elementary school students. Furthermore, there is a need for new indicators for teaching and evaluating collaborative movement in groups. Game performance results from the comprehensive integration of ball-manipulation skills and off-ball movement. This study did not examine the direct impact of the ADDS formation on the passing success rate. Although further validation of the effectiveness of the ADDS formation and an investigation of its specific applications are necessary, this study has provided a fresh perspective by showing that the ADDS construct potentially serves as one such indicator.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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