2025
04

ORIGINAL ARTICLE

Learning of gross motor skills based on fun games: a study of coordination development in 5–6-year-old children

Masrun[1ABDE], Ardo Okilanda[1BD], Khairuddin[2BC], Jaka Utama[1BD], Andra Rizky Putra[1BD]

[1] *Coaching Department, Sport Science Faculty, Universitas Negeri Padang, Indonesia*
[2] *Sport Education Department, Sport Science Faculty, Universitas Negeri Padang, Indonesia*

Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

Abstract

Background and Study Aim Coordination skills in early childhood are essential for overall physical, cognitive, and social development. However, conventional approaches to teaching basic motor movements often fail to produce optimal outcomes. The research aims to formalize learning basic movements based on fun games to develop the coordination of movements in children aged 5–6 years.

Material and Methods Forty-five children from several schools in Padang City, West Sumatra Province, Indonesia, comprised the experimental group, who participated in fun game-based movement learning. The control group did not engage in such learning. The experimental design for this study adopted the pre-test and post-test measurement and comparison method between the groups. The data collected were analyzed using covariance analysis with SPSS version 26.

Results The experimental group showed a significant difference in children's movement coordination development compared to the control group. They also showed significant differences in the development of the ability to perform balance beam, eye-hand coordination, jumping sideways, moving sideways, and shuttle throw among the sub-factors of the test items conducted for movement coordination, compared to the control group.

Conclusions The research results also indicated the importance of a fun game-based form of basic movement learning as an implication for Early Childhood Education programs. The movement-based learning model using fun games effectively teaches movement patterns while enhancing children's coordination, motivation, responsibility, and social skills. Its engaging nature makes it suitable for early childhood education, helping improve learning quality for children aged 5–6 across Indonesia.

Keywords: motor learning, fun game based, movement coordination, programs

Introduction

Motor coordination serves as a foundation for effective participation in physical activities and daily life during childhood. The development of coordination and the identification of effective learning approaches represent an important element in the system of educational practices in early childhood.

Early childhood is a critical period that shapes physical, cognitive, and socio-emotional development [1]. At this stage, posture and basic motor skills begin to form and require appropriate stimulation for healthy growth. Among various developmental domains, motor skills are fundamental for learning and adaptation [2]. Motor skills enable children to perform both gross (e.g., running, jumping) and fine (e.g., writing) movements, and their development depends on factors such as parenting and nutrition [3, 4]. Coordination, a key element of motor development, integrates multiple body systems to produce controlled and efficient movement [5]. It supports everyday actions and adaptive behavior in diverse situations [6, 7]. Insufficient stimulation can hinder motor progress, reduce confidence, and limit social interaction [8]. Coordination involves the integration of sensory and motor functions and is affected by age, fitness level, environment, and access to play [9, 10, 11]. Assessing posture transitions and dynamic movements helps identify coordination levels, which are linked to future motor potential [12, 13, 14, 15].

Children who are active in free and structured play tend to have better coordination than those with less motor stimulation. However, coordination does not develop automatically but requires appropriate learning strategies, even when physical activity is adequate [16]. Unfortunately, many teachers, parents, and coaches still lack an understanding of how to teach coordination systematically and engagingly, resulting in some children struggling to master basic movements. This emphasizes the need for transformative learning approaches that not only teach motor skills but also the context in which they are applied in various situations [17, 18]. Research indicates that physical activity and games effectively enhance coordination at all educational levels [19]. Different approaches, such as conventional methods, outdoor activities, and

doi:10.15561/26649837.2025.0401

fun games, can improve overall motor skills.

In physical education and early childhood development, fun games can improve children's motivation and learning outcomes. Through fun and interactive games, children can practice basic motor skills such as running, jumping, and playing with a ball [20]. These games encourage physical activity, reduce sedentary behavior, and support social development through activities like sharing, cooperation, and following rules [21]. One of the key strengths of fun games is their ability to stimulate movement coordination indirectly. These games simultaneously enhance children's physical, cognitive, social, and emotional skills [22]. During play, children engage in pressure-free learning that improves balance, distance estimation, limb coordination, and responsiveness to stimuli.

In addition to fun games, outdoor physical activities also play an essential role in children's motor development. Nature-based activities offer multisensory and social learning experiences through organized sports, free play, and exploration [23]. Compared to indoor activities, outdoor play provides greater sensory stimulation, encourages cooperation and communication, and benefits children's physical and mental health [24]. It strengthens muscles, improves overall endurance and fitness [25], and supports cognitive functions such as memory and focus [26]. Physical movement is crucial for motor development, both in sports and in daily tasks [27], with natural engagement in play requiring complex coordination between the brain and muscles [28]. Gross motor skills, such as running and jumping, improve a child's balance, strength, and overall physical health [29].

Children with good gross motor skills tend to be more confident and socially active [30], indicating that motor development also affects cognitive, social, and emotional domains. They are also more agile and efficient in completing daily tasks [31]. Given children's limited attention span, interesting and varied learning strategies are needed [32]. Engaging in fun physical activities can enhance concentration by improving blood flow to the brain, stimulating the release of endorphins, and supporting cognitive function. Outdoor play can also improve mood and mental alertness, contributing to overall development [33].

An analysis of previous research has shown that various learning approaches, including fun games and outdoor activities, contribute positively to the development of motor coordination in early childhood. Researchers have identified key components such as motivation, engagement, and multisensory experiences as important elements of effective movement-based learning. Despite extensive research on motor skill development, there is still a need to explore structured and engaging methods that are tailored to the developmental needs of young children. This study aims to identify and evaluate structured, engaging, and developmentally appropriate coordination learning strategies.

Materials and Methods

Participants

Participants were selected using purposive sampling techniques, resulting in a total of 45 children. They were divided into three groups: Experimental Group A (Fun Games), Experimental Group B (Outdoor Physical Activities), and the Control Group. Each group consisted of 15 children. To ensure comparable baseline abilities across groups, a blocked random assignment technique was applied based on pre-test scores. Participants were ranked from highest to lowest and grouped into 15 blocks, each containing three children with similar scores. Within each block, participants were randomly assigned to one of the three groups, resulting in balanced distribution in terms of initial motor coordination. The intervention was delivered to the experimental groups 16 times, with a frequency of three sessions per week.

The study was conducted in accordance with ethical standards for research involving human participants. Written informed consent was obtained from the parents or legal guardians of all participants prior to data collection. The research protocol was reviewed and approved by the institutional ethics committee of Padang State University.

Research Design

This study employed a quasi-experimental design with pre-test and post-test measurements across groups [34]. It aimed to examine the effectiveness of a fun game-based learning model formulated to improve motion coordination in kindergarten students at the Padang State University Development School. The game-based program was structured in two levels: Level 1 included simple coordination activities, while Level 2 involved more advanced coordination tasks.

The study began with the collection of pre-test data from children in both control and experimental groups. These data were used to ensure an equal distribution of initial abilities across the groups. The division aimed to maintain comparable coordination levels between the experimental and control groups before the intervention.

To assess coordination, the following motion coordination tests were used [35]:

(1) Balance Beam,
(2) Eye-Hand Coordination,
(3) Jumping Sideways,
(4) Moving Sideways, and
(5) Shuttle Throw.

The level of locomotor skills was measured using the Test of Gross Motor Development-2 (TGMD-

2), a standardized and internationally validated instrument for assessing children's gross motor development [36, 37, 38]. Its established reliability and validity support its use in evaluating the effectiveness of fun game-based motor learning interventions in children.

Procedure

The fun game-based movement coordination training model is illustrated in Figure 1

Based on Figure 1, the activities are designed to improve children's coordination, particularly eye-hand and eye-foot coordination. They also aim to develop fundamental motor skills such as running, jumping, throwing, catching, and balancing. The games are progressively structured and delivered in an engaging manner to promote active participation during learning. Conducted in groups, these activities foster cooperation, communication, and turn-taking. Additionally, children are encouraged to develop strategies collaboratively, select group leaders, and call each other's names when taking turns, thereby promoting positive social interaction.

The fun games intervention used in this study was designed as an alternative approach to incorporating structured play-based activities into motor coordination programs. The model was reviewed by five specialists in early childhood education and motor development, receiving an average score of 0.87 in terms of material content, objectives, and activity relevance, indicating alignment with expert-defined criteria. The model was organized into sequential stages with the aim of ensuring consistent implementation.

Game Rules

1. All teams are required to complete each task in order.
2. Each task must be completed before moving on to the next one.
3. Group discussion is required to determine the best strategy to complete the task.
4. A leader is appointed to make the final decision at each step of the game.
5. Group members call each other by name when giving turns, reinforcing interaction and communication.
6. Children are instructed to quickly and orderly move the plastic ball into the basket.

In addition, the children also ran and climbed on the blocks while remaining focused on the game. The game forms are described in Table 1.

Other Group

The Outdoor Physical Activity group engaged in activities aimed at developing children's gross motor skills through direct interaction with natural environments. These included light hiking, walking, jogging in open areas, and games such as jumping rope and cricket [39]. The activities were designed to stimulate coordination, balance, muscle strength, and social interaction through free exploration and teamwork. The outdoor setting offered diverse movement experiences and multisensory stimulation that contributed to children's overall development. All sessions were conducted within a single lesson hour and combined exploratory play with structured teacher guidance.

In contrast, the Conventional Motor Learning group participated in school curriculum-based activities such as light gymnastics, marching, and ball-throwing and catching exercises. These activities were carried out indoors, with a focus on repetitive

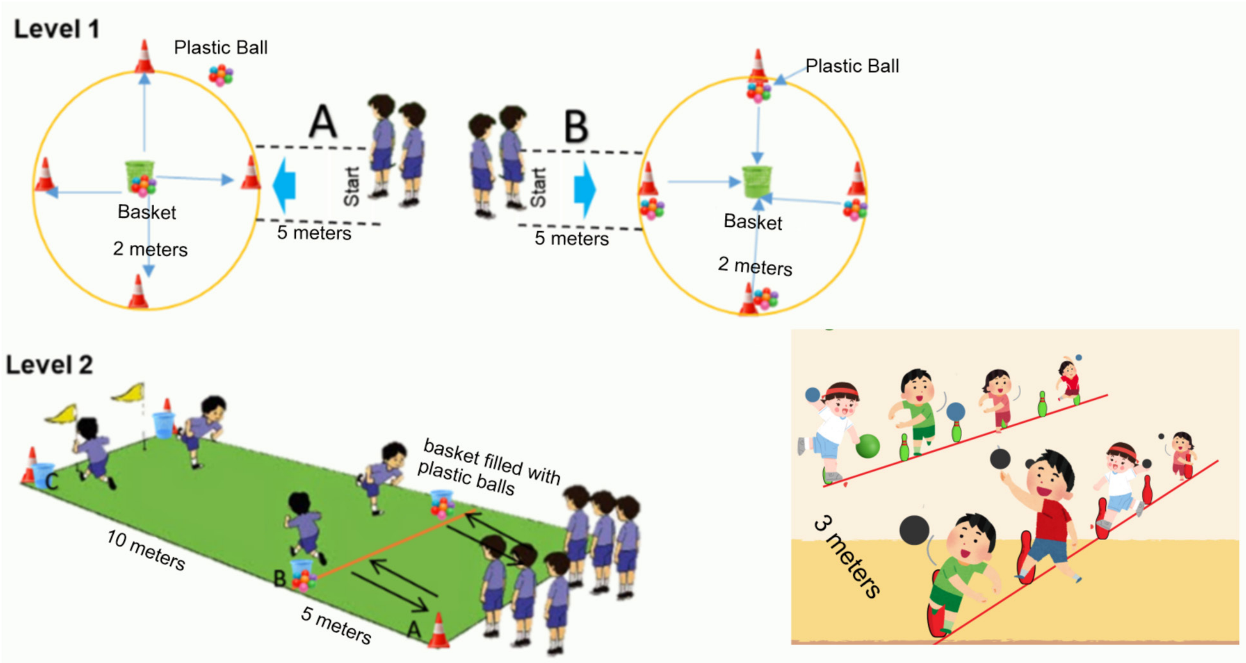

Figure 1. Motion Learning Activities (Author's own work)

movement patterns and direct teacher instruction. This method emphasized discipline and order but offered limited environmental variety and reduced opportunities for active child participation. The duration of these sessions was also one lesson hour.

Statistical Analysis

Before data analysis, preliminary tests were conducted to assess the distribution and suitability of the data. The Kolmogorov–Smirnov (KS) test was used to assess the normality of each variable, and the equality of the covariance matrix was examined. Statistical analysis was performed using the ANCOVA method, and all data were processed with the SPSS version 26 software package.

Results

Homogeneity

One of the key assumptions in ANCOVA is the homogeneity of regression slopes, meaning that the relationship between the covariate (pre-test scores) and the dependent variable (post-test scores) should be consistent across all groups (Experimental Group A, Experimental Group B, and Control Group). This assumption ensures that the covariate's influence on the outcome does not vary by group. To test this, an interaction analysis was conducted between the covariate (pre-test) and group factors on the dependent variable (post-test). The results of this analysis are presented in Table 2. As shown in the table, all p-values were above 0.05, indicating that there were no statistically significant interactions between pre-test scores and group membership for any coordination variable. Therefore, the assumption of homogeneity of regression slopes was satisfied.

Normality

Before conducting the ANCOVA analysis, the assumption of normal distribution was tested using the Kolmogorov–Smirnov test on the pre-test, post-test, and residual score data for each group and coordination aspect. According to the criteria, if $p > 0.05$, the data are considered normally distributed, and the assumption is satisfied. The results of this test are presented in Table 3. As shown in the table, all p-values were greater than 0.05, indicating that the data for each coordination aspect in all three groups were normally distributed.

ANCOVA

This study aimed to evaluate the effectiveness of the intervention in improving physical coordination in several sub-groups: Experimental Group A, Experimental Group B, and the Control Group. Measurements were taken across five coordination skill components—Balance Beam, Jumping Sideways, Moving Sideways, Eye-Hand Coordination, and Shuttle Throw—as well as the Coordination Total Score, which represents the combined score across all components. The results of this analysis are presented in Table 4. Overall, the Coordination Total Score in Experimental Group A and Experimental

Table 1. Game Forms

Level	Description	Skills Practised
Level 1	– Students are divided into two groups (A and B). – Each group stands at the starting point, 5 meters from the playing area. – In the center of the area is a basket (2 meters in diameter) with four colored cones and a plastic ball inside. – Taking turns, students run towards the basket and place the plastic ball inside.	Develops basic movement coordination, combining running speed and throwing accuracy.
Level 2	– Increased difficulty: the track is extended to 10 meters with designated points A, B, and C. – The plastic ball is placed at point A and moved in a zigzag path toward the main basket at point B. – The route includes obstacles, requiring students to jump and maintain balance while running along a defined path.	Enhances speed, accuracy, obstacle navigation, and overall body balance.

Table 2. Homogeneity Test Results

Coordination Aspect	Group Interaction	Description
Balance Beam	p = 0.45	Homogeneous
Jumping Sideways	p = 0.62	
Moving Sideways	p = 0.51	
Eye-Hand Coordination	p = 0.39	
Shuttle Throw	p = 0.48	
Coordination Total Score	p = 0.53	

Table 3. Normality Test Results

Coordination Aspect	Group	Pre-test (p)	Post-test (p)	Description
Balance Beam	Experiment A	0,200	0,157	Normal
	Experiment B	0,156	0,182	
	Control	0,179	0,168	
Jumping Sideways	Experiment A	0,162	0,143	
	Experiment B	0,194	0,134	
	Control	0,182	0,170	
Moving Sideways	Experiment A	0,184	0,173	
	Experiment B	0,152	0,198	
	Control	0,172	0,185	
Eye-Hand Coordination	Experiment A	0,148	0,162	
	Experiment B	0,169	0,144	
	Control	0,160	0,150	
Shuttle Throw	Experiment A	0,174	0,160	
	Experiment B	0,158	0,166	
	Control	0,176	0,182	
Coordination Total Score	Experiment A	0,196	0,151	
	Experiment B	0,141	0,173	
	Control	0,188	0,177	

Table 4. Mean and Standard Deviation, Pre-Test, and Post-Test Corrected by Movement Coordination Data Group for 5-6 Year Old Children

Sub-Group	Group	Pre Test		Post Test		Corrected post-test		p-value
		M	SD	M	SD	M	SD	
Balance Beam	Experimental group A	2.31	0.32	4.46	3.57	4.54	1.93	0.000**
	Experimental group B	2.41	0.34	3.84	4.26	3.80	1.12	0.000**
	Control group	2.31	0.32	2.55	2.70	3.51	0.87	0.130**
Jumping Sideways	Experimental group A	3.21	0.54	4.07	2.32	4.09	0.32	0.000**
	Experimental group B	2.62	0.45	3.76	3.43	3.75	1.23	0.000**
	Control group	2.41	0.34	2.40	2.18	3.39	1.43	0.121**
Moving Sideways	Experimental group A	3.12	0.77	4.01	4.29	4.06	0.78	0.000**
	Experimental group B	2.31	0.32	2.83	3.76	3.82	0.89	0.000**
	Control group	2.32	0.32	3.10	3.32	3.06	0.35	0.087**
Eye-Hand Coordination	Experimental group A	3.31	0.87	4.50	4.44	4.44	1.13	0.000**
	Experimental group B	2.32	0.32	4.27	4.09	4.29	0.45	0.000**
	Control group	2.23	0.23	2.20	3.09	3.24	0.84	0.170**
Suttle Throw	Experimental group A	2.11	0.21	4.15	4.24	4.17	1.22	0.000**
	Experimental group B	2.22	0.23	3.69	4.99	3.68	1.18	0.000**
	Control group	2.31	0.32	2.14	4.92	3.12	1.02	0.173**
Coordination Total Score	Experimental group A	14.12	4.56	21.85	4.23	20.65	4.23	0.000**
	Experimental group B	14.35	3.45	19.53	4.86	20.48	4.37	0.000**
	Control group	14.23	3.23	17.36	3.74	17.89	3.54	0.084**

Table 5. Post Hoc

Sub-Component	A vs Control	B vs Control	A vs B
Balance Beam	p < 0.01 (4.54 vs. 3.51)	p < 0.01 (3.80 vs. 3.51)	p < 0.05 (4.54 vs. 3.80, A > B)
Jumping Sideways	p < 0.01 (4.09 vs. 3.39)	p < 0.01 (3.75 vs. 3.39)	p > 0.05 (4.09 vs. 3.75)
Moving Sideways	p < 0.01 (4.06 vs. 3.06)	p < 0.01 (3.82 vs. 3.06)	p > 0.05 (4.06 vs. 3.82)
Eye-Hand Coordination	p < 0.01 (4.44 vs. 3.24)	p < 0.01 (4.29 vs. 3.24)	p > 0.05 (4.44 vs. 4.29)
Shuttle Throw	p < 0.01 (4.17 vs. 3.12)	p < 0.01 (3.68 vs. 3.12)	p > 0.05 (4.17 vs. 3.68)
Coordination Total Score	p < 0.01 (20.65 vs. 17.89)	p < 0.01 (20.48 vs. 17.89)	p < 0.05 (20.65 vs. 20.48, A > B)

Group B increased significantly from 14.12 to 21.85 (corrected 20.65) and from 14.35 to 19.53 (corrected 20.48), respectively, with a *p*-value of 0.000. Meanwhile, the Control Group showed only a slight increase from 14.23 to 17.36 (corrected 17.89), which was not statistically significant ($p = 0.084$). In the table, all statistically significant *p*-values are marked with (**), indicating a high level of significance ($p < 0.01$). This suggests that the interventions applied in Experimental Groups A and B had a measurable effect on coordination test outcomes, whereas the changes observed in the Control Group were likely due to chance rather than the intervention.

Table 5 presents the results of the post hoc analysis. Both experimental groups (A and B) showed statistically significant improvements in all coordination sub-components compared to the control group ($p < 0.01$). Group A demonstrated higher performance than Group B in the Balance Beam task and the Total Coordination Score ($p < 0.05$), while no statistically significant differences were observed between the two experimental groups in the remaining sub-components. These findings suggest that the intervention implemented in Group A may have been more effective in enhancing certain aspects of coordination than the approach used in Group B.

Discussion

This study aimed to identify and assess coordination learning strategies that are structured, engaging, and developmentally appropriate. The analysis indicated improvements in multiple aspects of coordination skills among children in the experimental groups (A and B) compared to the control group. The Fun Games approach, integrating elements of play into motor learning, appears to support children's engagement and motivation. Engaging in enjoyable activities during learning may contribute to increased participation and attentiveness among young learners [40].

The effectiveness of such strategies is closely linked to the teacher's ability to plan and deliver varied forms of instruction [41]. Considering that children differ in learning styles, interests, and developmental levels [42], the application of diverse teaching methods is important for supporting their cognitive, affective, and motor development [43]. Through methodical variation, educators can create learning environments that foster deeper understanding and sustain children's interest in physical activities [44].

Basic movement coordination in children may be developed through appropriately designed game-based activities. The Fun Games method integrates elements of play with structured physical exercises aimed at enhancing key coordination skills in an engaging and developmentally appropriate manner [45]. For instance, Balance Beam tasks are used to support postural control, Jumping Sideways contributes to foot coordination and agility, Moving Sideways develops lateral movement patterns, while eye-hand coordination games aim to improve targeting and precision. Shuttle Throw activities additionally engage throwing mechanics and coordination.

These structured activities, refined through a systematic development process and supported by existing research, may serve as a pedagogical tool for improving movement coordination. Moreover, the implementation of such methods in outdoor settings could support not only motor development, but also motivation, cooperative behavior, and social interaction in early childhood contexts [46]. Previous studies suggest that the integration of play-based strategies in physical education contributes to increased engagement and alignment with children's developmental needs [47, 48, 49, 50].

The present play-based learning model builds upon earlier findings by demonstrating its potential to enhance motor skills while supporting meaningful and engaging learning experiences for children [51]. Active participation in diverse movement-based contexts, including assessment procedures, has been associated with increased levels of engagement among young learners [52]. At the same time, several methodological considerations should be addressed to strengthen the validity of the findings. These include the possibility of group disparities, measurement bias, and individual differences in responsiveness to the intervention. Moreover, the long-term impact of the Fun Games approach remains to be fully examined, as motor coordination trajectories may vary over extended periods or within different educational and cultural settings [53]. Previous research has indicated that games may provide developmentally appropriate opportunities for learning, particularly in children aged 5–6 years who show high interest in play-based activities [54, 55, 56]. While play can foster creativity and external motivation, further investigation is needed to understand how internal motivation during movement-based learning can be effectively supported and sustained over time [57].

The discussion highlights that structured game-based learning approaches can positively contribute to the development of coordination skills in early childhood. By integrating elements of fun, cooperation, and physical challenge, such methods offer an engaging alternative to conventional physical education formats. The findings reinforce the importance of selecting pedagogical strategies that align with children's developmental needs and emphasize active, varied, and meaningful participation.

Limitations and Future Directions

This study presents several limitations that should be acknowledged. The intervention was conducted over a relatively short duration, which restricts conclusions regarding the long-term effectiveness and retention of coordination improvements. Furthermore, the sample was limited to a single kindergarten affiliated with Universitas Negeri Padang, which reduces the generalizability of the findings. The modest sample size and potential measurement biases may also influence the validity of the results. Future research should employ longitudinal study designs involving participants from diverse educational and cultural contexts. It is also recommended to use more objective measurement instruments and to compare multiple game-based and conventional movement learning models to determine the most effective strategies for enhancing children's coordination and broader developmental outcomes.

Conclusions

This study highlights the potential of structured, game-based physical activities as a developmentally appropriate approach in early childhood motor coordination programs. Integrating playful elements into movement-based learning may offer pedagogical value by promoting engagement, social interaction, and active participation among children. Such models can be considered in the planning and implementation of physical education curricula in early childhood settings, with attention to age-specific needs and educational objectives.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the research, authorship, or publication of this article.

References

1. Coombes L, Bristowe K, Ellis-Smith C, Aworinde J, Fraser LK, Downing J, et al. Enhancing validity, reliability and participation in self-reported health outcome measurement for children and young people: a systematic review of recall period, response scale format, and administration modality. *Quality of Life Research*, 2021;30(7): 1803–1832. https://doi.org/10.1007/s11136-021-02814-4
2. Gandotra A, Kotyuk E, Bizonics R, Khan I, Petánszki M, Kiss L, et al. An exploratory study of the relationship between motor skills and indicators of cognitive and socio-emotional development in preschoolers. *European Journal of Developmental Psychology*, 2023;20(1): 50–65. https://doi.org/10.1080/17405629.2022.2028617
3. Sutapa P, Pratama KW, Rosly MM, Ali SKS, Karakauki M. Improving Motor Skills in Early Childhood through Goal-Oriented Play Activity. *Children*, 2021;8(11): 994. https://doi.org/10.3390/children8110994
4. Białek-Dratwa A, Szczepańska E, Szymańska D, Grajek M, Krupa-Kotara K, Kowalski O. Neophobia—A Natural Developmental Stage or Feeding Difficulties for Children? *Nutrients*, 2022;14(7): 1521. https://doi.org/10.3390/nu14071521
5. Park J, Jeong J. Dribble Accuracy and Arm Coordination Pattern According to Motor Expertise and Tempo. *International Journal of Environmental Research and Public Health*, 2023;20(10): 5788. https://doi.org/10.3390/ijerph20105788
6. Gottwald V, Davies M, Owen R. Every story has two sides: evaluating information processing and ecological dynamics perspectives of focus of attention in skill acquisition. *Frontiers in Sports and Active Living*, 2023;5. https://doi.org/10.3389/fspor.2023.1176635
7. Kiliç Z, Uyanik G, Çağlak Sari S. Examining the Effects of Movement Activities of Coordinated Approach to Child Health (CATCH) Program on Locomotor and Manipulative Skills of 4-5 Years Old Children. *Participatory Educational Research*, 2022;9(1): 41–60. https://doi.org/10.17275/per.22.3.9.1
8. Szabo DA, Neagu N, Teodorescu S, Panait CM, Sopa IS. Study on the Influence of Proprioceptive Control versus Visual Control on Reaction Speed, Hand Coordination, and Lower Limb Balance in Young Students 14–15 Years Old. *International Journal of Environmental Research and Public Health*, 2021;18(19): 10356. https://doi.org/10.3390/ijerph181910356
9. Gallotta MC, Zimatore G, Falcioni L, Migliaccio S, Lanza M, Schena F, et al. Influence of Geographical Area and Living Setting on Children's Weight Status, Motor Coordination, and Physical Activity. *Frontiers in Pediatrics*, 2022;9. https://doi.org/10.3389/fped.2021.794284
10. Battaglia G, Giustino V, Tabacchi G, Lanza M, Schena F, Biino V, et al. Interrelationship Between Age,

Gender, and Weight Status on Motor Coordination in Italian Children and Early Adolescents Aged 6–13 Years Old. *Frontiers in Pediatrics*, 2021;9. https://doi.org/10.3389/fped.2021.738294
11. Pereira S, Bustamante A, Santos C, Hedeker D, Tani G, Garganta R, et al. Biological and environmental influences on motor coordination in Peruvian children and adolescents. *Scientific Reports*, 2021;11(1). https://doi.org/10.1038/s41598-021-95075-7
12. Uhlrich SD, Falisse A, Kidziński Ł, Muccini J, Ko M, Chaudhari AS, et al. OpenCap: Human movement dynamics from smartphone videos. Marsden AL (ed.) *PLOS Computational Biology*, 2023;19(10): e1011462. https://doi.org/10.1371/journal.pcbi.1011462
13. Kahraman Y. Postural Structure and Mechanic Syndromes Associated with Human Movement Physiology: A Traditional Review of Re-modelling Musculature. *Turkish Journal of Osteoporosis*, 2021;27(2): 61–67. https://doi.org/10.4274/tod.galenos.2021.49389
14. Stanković D, Horvatin M, Vlašić J, Pekas D, Trajković N. Motor Coordination in Children: A Comparison between Children Engaged in Multisport Activities and Swimming. *Sports*, 2023;11(8): 139. https://doi.org/10.3390/sports11080139
15. Benda RN, Marinho NFS, Duarte MG, Ribeiro-Silva PC, Ortigas PR, Machado CF, et al. A brief review on motor development: fundamental motor skills as a basis for motor skill learning. *Brazilian Journal of Motor Behavior*, 2021;15(5): 342–355. https://doi.org/10.20338/bjmb.v15i5.257
16. Nielsen-Rodríguez A, Romance R, Dobado-Castañeda JC. Teaching Methodologies and School Organization in Early Childhood Education and Its Association with Physical Activity. *International Journal of Environmental Research and Public Health*, 2021;18(7): 3836. https://doi.org/10.3390/ijerph18073836
17. Van Der Veer IPA, Rameckers EAA, Steenbergen B, Bastiaenen CHG, Klingels K. How do paediatric physical therapists teach motor skills to children with Developmental Coordination Disorder? An interview study. Capio CM (ed.) *PLOS ONE*, 2024;19(2): e0297119. https://doi.org/10.1371/journal.pone.0297119
18. Müller A, Bába ÉB, Židek P, Lengyel A, Lakó JH, Laoues-Czimbalmos N, et al. The Experiences of Motor Skill Development in Children with Autism Spectrum Disorder (ASD) Reflected through Parental Responses. *Children*, 2024;11(10): 1238. https://doi.org/10.3390/children11101238
19. Esen HT, Güçlüöver A, Kurnaz M, Altinkök M. The impact of coordination-based movement education model on balance development of 5-year-old children. *Frontiers in Psychology*, 2023;13. https://doi.org/10.3389/fpsyg.2022.1045155
20. Zhou Y, Wang M, Lin S, Qian C. Relationship between Children's Independent Activities and the Built Environment of Outdoor Activity Space in Residential Neighborhoods: A Case Study of Nanjing. *International Journal of Environmental Research and Public Health*, 2022;19(16): 9860. https://doi.org/10.3390/ijerph19169860
21. Mokhtar N, Xuan LZ, Lokman HF, Mat NHC. Theory, Literature Review, and Fun Learning Method Effectiveness in Teaching and Learning. *International journal of social science and education research studies*, 2023;03(08). https://doi.org/10.55677/ijssers/v03i8y2023-30
22. Garaigordobil M, Berrueco L, Celume MP. Developing Children's Creativity and Social-Emotional Competencies through Play: Summary of Twenty Years of Findings of the Evidence-Based Interventions "Game Program". *Journal of Intelligence*, 2022;10(4): 77. https://doi.org/10.3390/jintelligence10040077
23. Loebach J, Sanches M, Jaffe J, Elton-Marshall T. Paving the Way for Outdoor Play: Examining Socio-Environmental Barriers to Community-Based Outdoor Play. *International Journal of Environmental Research and Public Health*, 2021;18(7): 3617. https://doi.org/10.3390/ijerph18073617
24. Moreira M, Cordovil R, Lopes F, Da Silva BMS, Veiga G. The Relationship between the Quality of Kindergartens' Outdoor Physical Environment and Preschoolers' Social Functioning. *Education Sciences*, 2022;12(10): 661. https://doi.org/10.3390/educsci12100661
25. Chow HW, Chang KT, Fang IY. Evaluation of the Effectiveness of Outdoor Fitness Equipment Intervention in Achieving Fitness Goals for Seniors. *International Journal of Environmental Research and Public Health*, 2021;18(23): 12508. https://doi.org/10.3390/ijerph182312508
26. Mason L, Ronconi A, Scrimin S, Pazzaglia F. Short-Term Exposure to Nature and Benefits for Students' Cognitive Performance: a Review. *Educational Psychology Review*, 2022;34(2): 609–647. https://doi.org/10.1007/s10648-021-09631-8
27. Ginciene G, Amato C, Rodrigues De Oliveira E, Oliveira Dos Santos I, Dell Osbel E, Leonardi TJ. Understanding the pedagogical practice in futsal teaching and learning process based on the TGfU approach. *International Journal of Sports Science & Coaching*, 2023;18(1): 91–100. https://doi.org/10.1177/17479541211070790
28. Jopowicz A, Wiśniowska J, Tarnacka B. Cognitive and Physical Intervention in Metals' Dysfunction and Neurodegeneration. *Brain Sciences*, 2022;12(3): 345. https://doi.org/10.3390/brainsci12030345
29. Liu C, Cao Y, Zhang Z, Gao R, Qu G. Correlation of fundamental movement skills with health-related fitness elements in children and adolescents: A systematic review. *Frontiers in Public Health*, 2023;11. https://doi.org/10.3389/fpubh.2023.1129258
30. Magistro D, Cooper SB, Carlevaro F, Marchetti I, Magno F, Bardaglio G, et al. Two years of physically active mathematics lessons enhance cognitive function and gross motor skills in primary school children. *Psychology of Sport and Exercise*, 2022;63: 102254. https://doi.org/10.1016/j.psychsport.2022.102254
31. Ruban A, Radovenchyk A, Semal N, Bilohur V, Chkhailo M, Dzhym V. Sports Games in the Context of Developing Children's Coordination Ability as a Component of Physical

Development. *Revista Romaneasca pentru Educatie Multidimensionala*, 2024;16(3): 415–429. https://doi.org/10.18662/rrem/16.3/901
32. Breitwieser J, Brod G. Cognitive Prerequisites for Generative Learning: Why Some Learning Strategies Are More Effective Than Others. *Child Development*, 2021;92(1): 258–272. https://doi.org/10.1111/cdev.13393
33. Pujari V. Moving to Improve Mental Health - The Role of Exercise in Cognitive Function: A Narrative Review. *Journal of Pharmacy and Bioallied Sciences*, 2024;16(Suppl 1): S26–S30. https://doi.org/10.4103/jpbs.jpbs_614_23
34. Creswell WJ, Creswell JD. Research Design: Qualitative, Quantitative and Mixed Methods Approaches. SAGE Publications, Inc.; 2018.
35. Syahputra R, Bakhtiar S, Marta IA, Putri LP. The Profile of Students' Locomotor Skills Level in Elementary School. *Halaman Olahraga Nusantara (Jurnal Ilmu Keolahragaan)*, 2021;4(2): 138. https://doi.org/10.31851/hon.v4i2.5378
36. Bisi MC, Pacini Panebianco G, Polman R, Stagni R. Objective assessment of movement competence in children using wearable sensors: An instrumented version of the TGMD-2 locomotor subtest. *Gait & Posture*, 2017;56: 42–48. https://doi.org/10.1016/j.gaitpost.2017.04.025
37. Ulrich D. *Test of gross motor development 2: Examiner's manual.* (2nd ed.). Austin, TX: PRO-ED; 2000.
38. Apriyani I, Suntoda A, Budiman D. Uji Validitas Dan Reliabilitas Test Of Gross Motor Development-2 (TGMD-2) Dale A. Ulrich Pada Anak 9 Tahun. *TEGAR: Journal of Teaching Physical Education in Elementary School*, 2018;2(1): 40. https://doi.org/10.17509/tegar.v2i1.13780
39. Sääkslahti A, Niemistö D. Outdoor activities and motor development in 2–7-year-old boys and girls. *Journal of Physical Education and Sport*. 2021;21:463–8. https://doi.org/10.7752/jpes.2021.s1047
40. Tisza G, Markopoulos P. FunQ: Measuring the fun experience of a learning activity with adolescents. *Current Psychology*, 2023;42(3): 1936–1956. https://doi.org/10.1007/s12144-021-01484-2
41. Navarro SB, Zervas P, Gesa RF, Sampson DG. Developing teachers' competences for designing inclusive learning experiences. *J Educ Techno Soc.* 2016;19(1):17–27.
42. El-Sabagh HA. Adaptive e-learning environment based on learning styles and its impact on development students' engagement. *International Journal of Educational Technology in Higher Education*, 2021;18(1). https://doi.org/10.1186/s41239-021-00289-4
43. Dorji P, Gyeltshen C, Sanyasi GD, Sithub P, Dema T, Yangzom ., et al. The Impact of Early Child Care and Development Education on Cognitive, Psychomotor, and Affective Domains of Learning. *Asian Journal of Education and Social Studies*, 2020; 29–38. https://doi.org/10.9734/ajess/2020/v12i130303
44. Popovska Nalevska G, Kuzmanovska M. Teaching methods as a factor of students' learning motivation. *Education (Chula Vista),* 2020;2(3–4):40–50.
45. Adipat S, Laksana K, Busayanon K, Ausawasowan A, Adipat B. Engaging Students in the Learning Process with Game-Based Learning: The Fundamental Concepts. *International Journal of Technology in Education*, 2021;4(3): 542–552. https://doi.org/10.46328/ijte.169
46. Yıldırım G, Akamca GÖ. The effect of outdoor learning activities on the development of preschool children. *South African Journal of Education*, 2017;37(2): 1–10. https://doi.org/10.15700/saje.v37n2a1378
47. Merino-Campos C. Emotions in motion: A literature review of emotional experiences in physical education through video game practices. *Social Sciences & Humanities Open*, 2025;11: 101415. https://doi.org/10.1016/j.ssaho.2025.101415
48. Fan Y, Chong DK, Li Y. Beyond play: a comparative study of multi-sensory and traditional toys in child education. *Frontiers in Education*, 2024;9. https://doi.org/10.3389/feduc.2024.1182660
49. Feiyue Z. Edutainment Methods in the Learning Process: Quickly, Fun and Satisfying. *International Journal of Environment, Engineering and Education*, 2022;4(1): 19–26. https://doi.org/10.55151/ijeedu.v4i1.41
50. Lee-Cultura S, Sharma K, Giannakos M. Children's play and problem-solving in motion-based learning technologies using a multi-modal mixed methods approach. *International Journal of Child-Computer Interaction*, 2022;31: 100355. https://doi.org/10.1016/j.ijcci.2021.100355
51. Mavilidi MF, Ruiter M, Schmidt M, Okely AD, Loyens S, Chandler P, et al. A Narrative Review of School-Based Physical Activity for Enhancing Cognition and Learning: The Importance of Relevancy and Integration. *Frontiers in Psychology*, 2018;9. https://doi.org/10.3389/fpsyg.2018.02079
52. Newell KM, Rovegno I. Teaching Children's Motor Skills for Team Games Through Guided Discovery: How Constraints Enhance Learning. *Frontiers in Psychology*, 2021;12. https://doi.org/10.3389/fpsyg.2021.724848
53. Baranowski T, Blumberg F, Buday R, DeSmet A, Fiellin LE, et al. Games for Health for Children—Current Status and Needed Research. *Games for Health Journal*, 2016;5(1): 1–12. https://doi.org/10.1089/g4h.2015.0026
54. Bakhsh SA. Using Games as a Tool in Teaching Vocabulary to Young Learners. *English Language Teaching*, 2016;9(7): 120. https://doi.org/10.5539/elt.v9n7p120
55. Ali SR, Mukhtar F. A case study of fun learning with numeracy of preschoolers. *Southeast Asia Early Childhood Journal*, 2017;6: 51–58. https://doi.org/10.37134/saecj.vol6.6.2017
56. Iten N, Petko D. Learning with serious games: Is fun playing the game a predictor of learning success? *British Journal of Educational Technology*, 2016;47(1): 151–163. https://doi.org/10.1111/bjet.12226
57.Aksoy M, Belgin Aksoy A. An investigation on the effects of block play on the creativity of children. *Early Child Development and Care*, 2023;193(1): 139–158. https://doi.org/10.1080/03004430.2022.2071266

Information about the authors:

Masrun; (Corresponding author); https://orcid.org/0000-0003-4181-3473; masrun@fik.unp.ac.id; Coaching Department, Sport Science Faculty, Universitas Negeri Padang; Indonesia.

Ardo Okilanda; https://orcid.org/0000-0003-3439-6077; ardo.oku@fik.unp.ac.id; Coaching Department, Sport Science Faculty, Universitas Negeri Padang; Indonesia.

Khairuddin; https://orcid.org/0009-0001-2620-252X; khairuddins2@fik.unp.ac.id; Sport Education Department, Sport Science Faculty, Universitas Negeri Padang; Indonesia.

Jaka Utama; https://orcid.org/0009-0006-1342-8729; jakautama1990@gmail.com; Coaching Department, Sport Science Faculty, Universitas Negeri Padang; Indonesia.

Andra Rizky Putra; https://orcid.org/0009-0007-1587-9467; andra12izky@gmail.com; Coaching Department, Sport Science Faculty, Universitas Negeri Padang; Indonesia.

Cite this article as:

Masrun, Okilanda A, Khairuddin, Utama J, Putra AR. Learning of gross motor skills based on fun games: a study of coordination development in 5–6-year-old children. *Pedagogy of Physical Culture and Sports,* 2025;29(4):233–242.
https://doi.org/10.15561/26649837.2025.0401

Received: 09.06.2025
Accepted: 14.07.2025; Published: 30.08.2025