Investigating the effect of a 12-week game skill-based activity in physical education to enhance movement competence of students: a randomized trial

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Abstract

Background and Study Aim	Improving students' physical competence and engagement relies on effective physical education programs. The use of innovative teaching methods is becoming increasingly prevalent in education. This study aims to investigate the effect of game skill-based activity in physical education to enhance movement competence of students.
Material and Methods	The study included 60 students, aged 18 to 21, from different universities. They were divided into experimental and control groups using a quasi-experimental design. The Movement Competency Screen (MCS) was used for assessment. The movement competency test evaluated students' movement skills before and after the intervention. The test included bodyweight squats, lunges and twists, push-ups, bend-and-pull exercises, and single-leg squats.
Results	There were no significant differences in motor competence screening scores between the two groups (p > .05). However, the experimental group showed significant improvements across all movement competency screen assessments. This finding highlights the effectiveness of game-based learning in enhancing skill acquisition, coordination, and overall physical skills. In contrast, the control group demonstrated only a moderate increase in movement skills. The results suggest that the game-based collaborative learning method positively impacted motor competence. It promoted the regulated, harmonious, and holistic development of students' movement skills.
Conclusions	The study postulates that a 12-week game skill-based activity in physical education promotes physical competency. It also offers social and psychological benefits. This approach presents a promising pedagogical method to enrich physical education experiences. It encourages cooperation, teamwork, and active participation among students, fostering a more supportive and dynamic learning environment.
Keywords:	movement competence, game-based learning, skill performance, physical education

Introduction

Recently, movement skills in physical education have gained increasing importance as schools emphasize overall student development. The effectiveness of innovative pedagogical approaches in physical education classes significantly influences student engagement and academic performance [1, 2, 3]. Movement skills serve as a fundamental basis for physical fitness. They also foster cognitive, social, and emotional growth, which are essential for maintaining well-being [4, 5].

However, conventional methods in physical education, often characterized by repetitive drills and teacher-centered sessions, may lead to student disengagement. These methods can also limit opportunities for skill development tailored to diverse learning needs [6, 7]. Numerous studies highlight the significance of collaborative game-based learning for enhancing movement skills and creating a supportive educational environment

[8, 9, 10]. Yet, gaps remain in understanding the comprehensive efficacy of these methods across diverse movement patterns.

Numerous scholars have found that games effectively engage students in an integrative manner [11, 12]. Implementing games in classroom instruction is essential for achieving significant learning outcomes. In physical education, games provide valuable opportunities for promoting collaboration and social interaction [2, 12]. They are a common tool for teaching technical and tactical skills relevant to sports in physical education programs [13]. Using games as an educational tool allows students to engage with theoretical knowledge in an enjoyable and stimulating way [6, 14]. As a result, educators can enhance student engagement in both practical activities and classroom settings [6, 15]. Many studies have shown that games in physical education can boost enjoyment [16], increase motivation [13], improve decision-making [8], and facilitate skill acquisition [17, 18]. These pedagogical methods highlight the importance of student engagement in the learning process. They emphasize enjoyable approaches, such as collaborative game-based learning, within the context of physical education [19, 20, 21].

A substantial body of research has investigated the impact of collaborative game-based learning on the development of movement skills to enhance fundamental abilities [6, 9]. Studies indicate that collaborative learning environments, supported by individual modelling and feedback, lead to better performance and skill acquisition [9, 10]. One investigation assessed the effectiveness of cooperative and collaborative learning methods in improving sports skills among elementary school students. This quasi-experimental study included 50 students divided into one control group and two experimental groups. According to Dyson et al. [22], cooperative and collaborative teaching strategies significantly improved students' sports skill learning.

Navigating the realms of physical education and sports shows that integrating innovative teaching approaches, such as collaborative game-based learning, meets the needs of the current information-driven sector [19, 23]. At the same time, it addresses the complex challenges presented by various movement studies.

Research on current issues in movement competency screening highlights the urgent need for a standardized methodology. Such a methodology should precisely evaluate baseline skill levels, guide focused interventions, and efficiently monitor individual progress over time [24, 25]. This finding underscores the critical importance of comprehensive assessment methods. These methods enhance movement skill competency and promote sustained participation in physical education activities.

Movement Competency Screening (MCS) and game-based learning (GBL) are innovative methods for improving movement skills in physical education. This integration supports the individualized assessment and improvement of movement patterns. It also engages students through interactive and cooperative learning. Recent research has shown that this strategy can address gaps in traditional physical education. Conventional methods often fail to meet the diverse learning needs of students [2, 26]. The movement competency screen evaluates core skills. It identifies areas where students may need instruction to prevent injuries and improve their physical abilities [27, 28].

In educational institutions, movement competency screens help instructors assess baseline movement ability. They also enable instructors to adapt interventions to improve skill acquisition. Research shows that movement competency screens enhance students' balance, coordination, power, and movement quality. These benefits are especially evident when the screens are tailored to students' skill levels [27, 29]. Additionally, studies suggest that game-based learning environments improve cooperation, motivation, and social development. This approach makes physical education more enjoyable and inclusive [6, 8]. A study by Fizi et al. [13] and Harvey et al. [2] found that game-based learning activities provide repeated practice of movement skills in gaming situations. This method supports physical education goals by improving skill retention and mastery.

Numerous studies indicate that game-based learning can enhance student engagement and academic performance. This approach fosters an interactive environment that encourages skill development through collaboration and immediate feedback [16, 23]. For example, several studies have found that students who participated in collaborative game-based activities reported higher engagement and motivation. They also showed improvements in movement skill proficiency [3, 12, 13]. This method not only enhances students' motor skills but also addresses the emotional aspects of learning. These aspects include motivation, self-esteem, and enjoyment in physical activity.

Research on current issues in movement competency screening highlights the pressing need for frameworks that provide personalized evaluations and specific interventions. However, despite its potential, movement competency screening is still underutilized in combination with collaborative game-based learning methodologies, especially in physical education settings. Movement competency screening offers significant insights into students' basic movement skills and areas needing improvement. Yet, its application in interactive learning contexts remains limited.

There is a clear need to explore how movement competency screening can be integrated into collaborative game-based learning frameworks. This integration could enhance student movement skill development, promote engagement, and accommodate diverse student needs. Therefore, this study aims to investigate the effect of game skill-based activity in physical education to enhance movement competence of students.

Materials and Methods

Participants

The participants in this study were exclusively college students enrolled in the First Semester of 2024-2025. A total of 60 students, aged 18 to 21 (M = 18.06; SD = 0.78), were selected from various universities. Random sampling was conducted in PE classes, with 30 students assigned to the experimental group and 30 to the control group. Students with disabilities, immune-compromised conditions, or a history of cardiovascular difficulties were exempted from testing due to their unique health needs. The details of the participant groups are shown in Table 1.

Table 1. Subject Features

Group	Male N	Female N	Total
Experimental	15	15	30
Control	15	15	30

Research Design

Prior to the start of the experiment, the study complied with ethical standards. All participants were informed of the study protocols, and informed consent was obtained from each participant. Each participant completed a brief questionnaire about their personal information and history of sports- or physical activity-related injuries. No participants were disqualified from the study, as none presented issues warranting exclusion based on the questionnaire results. A quasi-experimental design was used, which included pre- and post-tests to evaluate fundamental movement skills. The control group received conventional basic movement instructions. In contrast, the experimental group participated in a 12-week game skill-based activity designed to enhance movement competence. Both groups underwent the same pre- and post-intervention skill assessments. Five movement competency screening assessments were conducted to evaluate fundamental movement skills: (1) bodyweight squat, (2) lunge and twist, (3) push-up, (4) bend and pull, and (5) single-leg squat. These assessments are appropriate for evaluating fundamental movement competencies [27]. Afterward, students from both groups participated in a 12-week Physical Education curriculum under comparable conditions. These conditions included class duration, facility use, and environmental factors.

Experimental Group Design. The researchers implemented a 12-week game skill-based activity framework for the experimental group. Students engaged in diverse game-based movement tasks that required cooperative effort for successful execution. To promote shared responsibility and support, each task demanded active participation from all group members. Tasks were designed to cover various aspects of movement competency assessment. This approach facilitated comprehensive enhancement of participants' performance skills. Students were instructed to work together to achieve common goals. Positive interdependence was developed through shared rewards for group participation, emphasizing the importance of collaboration. Students were responsible for their individual contributions to the group's success. Regular peer evaluations and performance assessments ensured fair and active involvement. Instructors in the experimental group served as facilitators rather than traditional educators. They provided direction, feedback, and support using collaborative learning methods such as peer teaching, learning circles, and group activities. These methods aimed to increase student engagement. The collaborative game-based learning approach was expected to improve movement performance, essential abilities, and interpersonal skills. It also aimed to enhance students' self-efficacy. Standardized assessments, along with feedback from students and instructors, were used to evaluate these outcomes.

Control Group Design. The control group participated in a standard physical activity regimen. This regimen included fundamental movement patterns, games, tactics, and sport-specific drills commonly used in physical education programs in Higher Education Institutions (HEIs). To ensure comparability, the sessions matched the experimental group in frequency and duration. The sessions were held once a week for a specified duration. The curriculum incorporated textbooks, instructional videos, and written exercise and assignment instructions. Teachers conducted the sessions and guided students through exercises and evaluations. This approach emphasized direct instruction and individual achievement rather than group participation. The program focused on improving skill performance, refining fundamental abilities, and fostering sportsmanship. The activities aimed to enhance overall physical ability and develop sport-specific skills in line with physical education goals. The control group's performance and progress were evaluated using standard measurements and instructor observations. These assessments ensured compliance with the physical activity regimen.

Regular evaluations were conducted to track improvements in physical fitness, skill proficiency, and other relevant outcomes. The effectiveness of the conventional learning method was determined by comparing students' initial movement abilities and fitness levels with those measured post-intervention. This comparison helped identify the effects of the collaborative learning strategy and assess its effectiveness relative to conventional teaching methods.

Assessment of Movement Competency Screen (MCS)

1. *Bodyweight Squat:* Stand with your fingertips positioned at the sides of your head. Descend into a squat as far as is comfortable. Return to the standing position.
2. *Lunge and Twist:* Cross your arms and place your hands on your shoulders, with your elbows directed forward. Step into a forward lunge, then twist your torso toward the front knee. Return to the center and resume the standing position. Alternate legs with each repetition.
3. *Push-up:* Perform a standard push-up, maintaining proper form throughout the movement.
4. *Bend and Pull:* Start with your arms extended overhead. Lean forward, allowing your arms to lower beneath your torso. Pull your hands toward your torso, mimicking the motion of a barbell row. Return to the starting position with your arms extended overhead.
5. *Single-Leg Squat:* Perform a bodyweight squat on one leg, with your fingertips resting on the sides of your head. Extend the non-weight-bearing leg behind your torso. Descend into the squat as far as is comfortable, then return to the standing position.

Statistical Analysis

The data were analyzed using SPSS version 20. Descriptive statistics — including the mean, frequency, and standard deviation — were used to examine the quantitative data. Pre- and post-test scores within each group were compared using a paired sample t-test. Differences between the experimental and control groups were assessed using an independent sample t-test. The significance threshold was set at $p < 0.05$.

Results

A pre-experimental movement competency test was conducted for both the experimental and control groups. This test established a baseline for evaluating students' movement skill performance and ensured comparable outcomes. The results are presented in Table 2. Table 2 shows the average differences in movement competency screening assessments between the control and experimental groups of college students before the implementation of the collaborative game-based learning method. No significant differences were observed in any of the movement competency screening assessments between the two groups ($p > .05$). This indicates that the movement skill performance of the two groups was similar. Consequently, the 12-week game skill-based activity in the Physical Education course could proceed for each designated group.

Movement assessments were used to compare the experimental and control groups after the experiment in the final phase of the Physical Education course. The same tests from the original assessment were utilized. The outcomes of the independent samples t-test for these comparisons are displayed in Table 3. The results revealed a significant difference in movement competency screening tests between the control and experimental groups after the 12-week game skill-based activity. Following the experiment, the mean scores across all five movement competency tests were significantly higher in the experimental group compared to the control group ($p < .001$). These

Table 2. Pre-test scores for both experimental and control groups

Movement Patterns	Groups	N	M	SD	t-value	p-value
Body Weight Squat	Experimental	30	5.70	1.055	-0.697	0.489
	Control	30	5.87	.776		
Lunge and Twist	Experimental	30	5.57	1.07	-0.217	0.829
	Control	30	5.63	1.30		
Push Up	Experimental	30	4.80	.41	-1.908	0.061
	Control	30	5.10	.76		
Bend and Pull	Experimental	30	5.70	1.02	-1.776	0.081
	Control	30	6.13	.86		
Single Leg Squat	Experimental	30	5.0	.743	-1.795	0.078
	Control	30	5.40	.97		

Table 3. Post-test scores for both experimental and control groups

Movement Patterns	Groups	N	M	SD	t-value	p-value
Body Weight Squat	Experimental	30	9.00	1.76	2.363	.021
	Control	30	8.17	0.79		
Lunge and Twist	Experimental	30	8.63	0.67	3.471	<.001
	Control	30	7.87	1.01		
Push Up	Experimental	30	13.50	1.53	5.643	<.001
	Control	30	11.47	1.25		
Bend and Pull	Experimental	30	8.30	1.37	3.385	<.001
	Control	30	7.40	0.50		
Single Leg Squat	Experimental	30	11.13	1.01	4.595	<.001
	Control	30	9.93	1.02		

Table 4. Paired sample t-test of scores in the experimental and control groups on movement competency test

Variable	Group	Pre-Test M ± SD	Post-Test M ± SD	t-value	p-value
Body Weight Squat	Experimental	5.70 ± 1.06	11.14 ± 1.01	-19.242	< .001
	Control	5.87 ± 0.78	9.93 ± 1.02	15.503	< .001
Lunge and Twist	Experimental	5.57 ± 1.07	13.50 ± 1.53	-24.68	< .001
	Control	5.63 ± 1.30	11.47 ± 1.25	16.858	< .001
Push Up	Experimental	4.80 ± 0.41	9.0 ± 1.76	-12.101	< .001
	Control	5.10 ± 0.76	8.17 ± 0.79	16.024	< .001
Bend and Pull	Experimental	5.70 ± 1.02	8.63 ± 0.669	-13.372	< .001
	Control	6.13 ± 0.86	7.47 ± 1.01	6.966	< .001
Single Leg Squat	Experimental	5.0 ± 0.74	8.30 ± 1.37	-14.006	< .001
	Control	5.40 ± 0.97	7.40 ± 0.50	10.117	< .001

findings demonstrate that the collaborative game-based learning technique positively influenced movement competency. It fostered regulated, harmonious, and holistic growth in students' movement skill performance.

Movement assessments were used to compare the experimental and control groups after the experiment in the final phase of the Physical Education course. The same tests from the original assessment were utilized. The outcomes of the independent samples t-test for these comparisons are displayed in Table 3. The results revealed a significant difference in movement competency screening tests between the control and experimental groups after the 12-week game skill-based activity. Following the experiment, the mean scores across all five movement competency tests were significantly higher in the experimental group compared to the control group (p < .001). These findings demonstrate that the collaborative game-based learning technique positively influenced movement competency. It fostered regulated, harmonious, and holistic growth in students' movement skill performance.

Discussion

This study aimed to evaluate the efficacy of a 12-week game-based learning program in improving skill performance among students in physical education classes. The findings support previous research that highlights the benefits of collaborative learning for enhancing skill performance and fostering strong connections among students [9, 10]. Furthermore, earlier studies have demonstrated that collaborative game-based learning effectively enhances skill development and social competencies in educational settings [6, 15].

The study results show a statistically significant improvement in all movement competency tests for the experimental group. This demonstrates the effectiveness of the 12-week game skill-based activity in the Physical Education course

for enhancing students' movement skills. These findings align with prior research that highlights how game skill-based activities foster an engaging learning environment. In such environments, students actively participate and support each other, leading to improved physical abilities and outcomes [12, 15]. These pedagogical approaches promote greater student engagement in physical activity tasks. As a result, they improve movement abilities, balance, and coordination [15, 30, 31].

Furthermore, numerous studies have demonstrated that game skill-based activities in Physical Education can significantly enhance physical skills. These skills include power, stamina, and endurance. This is achieved by incorporating movement patterns that promote individual skill development and collaborative problem-solving [26, 29]. Game skill-based activities engage students in attaining physical goals. They also promote peer learning, where students observe and emulate effective strategies from their peers. This results in an overall improvement of physical competencies. Thus, game-based learning has been linked to increased motivation and performance in Physical Education environments [9, 23]. Collaborative environments often boost intrinsic motivation by fostering a sense of belonging and purpose. This occurs because each individual contributes to the group's success [23]. Increased motivation is important because it encourages students to overcome physical challenges, set personal performance goals, and consistently participate in physical activities. Research shows that this collaborative approach not only enhances motivation but also fosters self-efficacy [32]. As a result, students develop confidence in their physical abilities, which further improves skill performance [17, 33].

Similar research in physical education found that incorporating collaborative game-based learning techniques into sports and physical activity instruction increases engagement, success, and skill acquisition [8, 9, 10]. This suggests that students not only improve sport-specific skills but also develop stronger social relationships and teamwork abilities. Furthermore, research has highlighted the positive effects of game skill-based activities on student engagement in physical education settings [9]. These findings emphasize that using game-based learning methods in PE classes significantly boosts students' motivation. This increased motivation is essential for sustaining long-term engagement. A study conducted by Casey and Quennerstedt [10] investigated the use of skill-based learning techniques in teaching physical education and sports skills. Their findings show that these techniques substantially enhance student engagement and skill acquisition. Both of these factors are necessary for effective learning outcomes in physical education.

These studies provide a fundamental understanding of the benefits of skill-based learning, particularly in improving movement competence in physical education programs. Although recent findings support this approach [16, 19, 26], some critics argue that tactical games may limit its applicability. They suggest that this method is less suitable for aspects of physical education involving less structured or more customized physical activities and sports.

In addition, prior research has shown that a collaborative game-based learning strategy enhances not only physical capabilities but also psychological factors. These factors include motivation, confidence, optimism, and self-efficacy [23, 32, 33]. This suggests that collaborative game-based learning has a substantial effect that goes beyond improving physical skills. It also promotes emotional and social growth. These comprehensive findings allow researchers to propose further investigations into the adaptation and modification of collaborative game-based learning strategies. This could help enhance various physical education environments and support all dimensions of student learning and skill development. This comprehensive approach situates the study within the broader framework of prior research [9, 10, 20]. It provides a more thorough analysis and highlights the diverse benefits of collaborative game-based learning in physical education.

This body of knowledge is enriched by research that examines the implementation of collaborative game-based learning within physical education. The current study not only supports previous findings but also expands upon them. It demonstrates that collaborative game-based learning can lead to measurable improvements in fundamental movement skills.

The findings suggest that this approach fosters a comprehensive physical education experience. It emphasizes teamwork, mutual support, and personal development. These elements are crucial for sustaining lifelong engagement in physical activity and sports. Future studies could explore these dimensions further by analyzing the effects of different collaborative tasks on specific physical skills. Additionally, researchers may investigate how these improvements correlate with real-world physical performance and health outcomes.

Limitations of the Study

Although the current research offers novel insights into how collaborative game-based learning improves students' movement skill performance, it is important to acknowledge its limitations. First, the sample was limited to first-year college students participating in PATHFIT 1 at MSU-Iligan Institute of Technology. This restricts the relevance of the findings to other age demographics, educational levels, or students from different institutions.

The limited demographic breadth may affect the generalizability of the results to larger populations. Moreover, the study excluded individuals with disabilities, immunocompromised conditions, or a history of cardiovascular issues, focusing solely on healthy participants. Although this approach ensured participant safety, it implies that the findings may not be entirely applicable to students with diverse health needs. Finally, while the collaborative game-based learning approach yielded positive outcomes, its specific framework and tasks may limit its applicability to other forms of physical education that do not incorporate tactical or game-based learning.

To address these limitations, future studies could expand the participant demographic to include students of different ages, educational backgrounds, and health conditions. This would provide insights into how collaborative game-based learning affects diverse physical education groups. To determine long-term advantages, future research could investigate the effects of collaborative learning on movement proficiency, physical fitness, and psychological factors such as motivation and self-efficacy. Additionally, applying collaborative learning to physical activities beyond tactical or game-based tasks may reveal its benefits for a broader range of skills and competencies. Finally, collecting qualitative data through interviews or surveys with participants and instructors may shed light on subjective collaborative learning experiences and contextualize quantitative findings. These improvements would deepen our understanding of collaborative game-based learning and its potential to enhance movement skill performance in physical education settings.

Conclusions

This study highlights the potential of a 12-week game skill-based activity in physical education to enhance movement competence among students. The collaborative game-based learning approach facilitates skill acquisition while fostering teamwork, motivation, and engagement - elements vital for comprehensive development in physical education. To effectively meet the diverse needs of students and improve skill development, educators should employ a variety of instructional approaches. Collaborative game-based learning is particularly recommended for promoting physical skills and social competence. Broader implementation of this method in different study groups and sports training programs may yield beneficial outcomes. Furthermore, educators should be informed about the advantages of integrating multiple pedagogical strategies to create tailored instruction. This will help establish a holistic and effective learning environment that accommodates students' varied interests and proficiency levels.

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