



The Implementation of Big Ball Game-Based Learning Models on Psychomotor Skills Across Self-Efficacy Levels in Students Aged 15-16 Years

Defri Mulyana^{1*}, Komarudin², Nevitaningrum³, Trisnar Adi Prabowo⁴

^{1,3}Department of Physical Education, Universitas Siliwangi, Indonesia

²Department of Sport Education, Universitas Pendidikan Indonesia, Indonesia

⁴Physical Education of Study Program, Universitas Muhammadiyah Brebes, Indonesia

*Corresponding Author: Defri Mulyana, e-mail: defrimulyana@unsil.ac.id

Received: 06 June 2026, Approved: 04 August 2026, Published: 30 September 2026

Abstract

Studi purpose. This study compared the effectiveness of Problem-Based Learning (PBL) versus Project-Based Learning (PjBL) using Big Ball games on psychomotor outcomes across self-efficacy levels in students aged 15–16 years.

Materials and Methods. Participants were 40 students: 20 males (age 15.7 ± 3.9 years; height 164.7 ± 7.2 cm; weight 59.4 ± 2.2 kg) and 20 females (age 15.5 ± 7.1 years; height 160.3 ± 2.5 cm; weight 53.1 ± 0.6 kg). This experimental study used a two-group pretest–posttest design with ordinal pairing (A–B–B–A). The intervention lasted 6 weeks (18 sessions) and covered basic techniques in football, basketball, and volleyball at 65%–75% intensity or moderate perceived exertion (RPE: 12–14). Self-efficacy was measured with the Endurance Sport Self-Efficacy Scale (ESSES) and psychomotor skills with the Test of Gross Motor Development-3 (TGMD-3). Analyses were conducted in SPSS 27, using MANCOVA while controlling for pretest self-efficacy and psychomotor scores.

Results. MANCOVA showed a significant multivariate treatment effect on posttest outcomes after controlling for pretest scores ($F=2.348$, $p=0.042$). Gender also had a significant multivariate effect ($F=3.562$, $p=0.041$), while the group×gender interaction was not significant ($F=0.545$, $p=0.772$). Univariate tests indicated no significant group effect on posttest self-efficacy ($p=0.354$), but a significant group effect on posttest psychomotor skills ($p=0.006$; $\eta^2=0.337$). Gender did not significantly affect self-efficacy ($p=0.645$) but significantly affected psychomotor skills ($p=0.024$; $\eta^2=0.159$); no significant group×gender interaction was found for either outcome ($p=0.583$). Estimated marginal means showed similar self-efficacy for males (89.43) and females (89.96), higher psychomotor performance for males (93.02) than females (90.58), and higher psychomotor scores in the PjBL group than the PBL group.

Conclusions. Both Big Ball game-based learning approaches improved students' self-efficacy, but PjBL produced greater gains in psychomotor skills in 15–16-year-old students. Further research should use larger, more diverse samples or longer interventions.

Keywords: Physical Education Learning, Big Ball Games, Adolescent Motor Skills, Self-Efficacy

DOI: <https://doi.org/10.52188/ijpess.v6i3.2236>

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Introduction

Problem-Based Learning (PBL) and Project-Based Learning (PjBL) have gained significant attention in physical education as innovative pedagogical approaches that may enhance student engagement and learning outcomes. PBL is known for encouraging students to actively analyze and solve real-world problems (H. Li et al., 2022), thereby increasing learning interest and effectiveness through active participation (Liu et al., 2023). Meanwhile, PjBL, through its stages of planning, implementation, and evaluation, offers opportunities for in-depth skill development through repeated practice and team collaboration (Nafiâ et al., 2022; Bafadal & Haetami, 2021). Both PBL and PjBL have been shown to gradually improve physical fitness, academic performance, and students' enjoyment of learning (Elumalai et al., 2022). Nevertheless, the two models emphasize different learning processes. PBL primarily guides students to identify, analyze, and formulate solutions to contextual problems, whereas PjBL requires students to produce and demonstrate a tangible performance through sustained cycles of planning, practice, evaluation, and refinement. These differences may result in distinct effects on the acquisition of psychomotor skills, particularly when physical performance requires repeated and progressively structured practice. The application of these models is particularly relevant in physical education for adolescents aged 15-16, a crucial developmental period for the consolidation of motor skills (Karadeniz et al., 2023).

Psychomotor skills refer to the ability to coordinate body movements and cognitive processes to perform tasks effectively and efficiently, involving precision, speed, and coordination (Lorås et al., 2024). These skills extend beyond physical capacity to include cognitive elements such as planning and decision-making (O'Brien et al., 2023; Biino et al., 2023). At the ages of 15-16, students are expected to have achieved higher motor control, enabling them to master more complex movements in sports and physical activities (Ahn & Won, 2023), and to begin showing specialization that demands more advanced psychomotor capabilities (Makaruk et al., 2023). The development of psychomotor skills is greatly influenced by various factors, including psychological conditions. One crucial psychological factor is self-efficacy, defined as an individual's belief in their ability to succeed in a particular task or situation (Prabowo et al., 2025; Oloo, 2024). Self-efficacy directly affects effort, persistence, and learning strategies for physical skills, where students with high self-efficacy tend to be more motivated and proactive, potentially achieving more optimal psychomotor performance (Masrun & Rusdinal, 2022; Cagongan & Osorno, 2022).

To enhance self-efficacy and psychomotor skills among 15-16-year-old students, engaging and challenging learning approaches involving games, particularly Big Ball games, have been shown to be highly effective (Bravo-Bravo et al., 2023; Safitri et al., 2025). Activities in Big Ball games require continuous movement, quick decision-making, interaction, and application of basic techniques, all of which can simultaneously build students' self-efficacy regarding their physical abilities (Peng & Zhang, 2021). Research evidence indicates that learning models incorporating Big Ball games can influence self-efficacy and/or psychomotor abilities, such as improvements in fitness and technical skills among football players (Duncan et al., 2022; Marshall et al., 2023) and basic motor skills such as underhand passing in volleyball (Nsaif, 2023). However, previous studies have commonly examined a single sport, a specific technical skill, or one pedagogical model in isolation. Consequently, the available evidence provides limited explanation of whether PBL or PjBL is more effective when football,

basketball, and volleyball skills are integrated into a structured Big Ball game-based learning program.

Although the literature has examined the effectiveness of PBL and PjBL in physical education and the role of self-efficacy in motor learning, there remains a research gap regarding differences in psychomotor outcomes between PBL and PjBL based on varying levels of student self-efficacy in the context of game-based learning involving Big Ball sports among adolescents. Practical issues in schools often reveal variations in students' psychomotor abilities influenced by their self-efficacy levels. However, few studies have directly compared how these two innovative pedagogical models interact with students' self-beliefs to produce motor performance. This gap highlights the need for a deeper understanding of the mechanisms underlying the effectiveness of these teaching models in psychomotor development.

Therefore, the aim of this study is to focus on the effectiveness of Problem-Based Learning (PBL) and Project-Based Learning (PjBL), implemented through Big Ball games, on psychomotor performance based on self-efficacy levels among 15-16-year-old students. The novelty of this study lies in directly comparing PBL and PjBL through an integrated Big Ball game-based program involving football, basketball, and volleyball, while considering students' initial self-efficacy levels. The selection of PBL and PjBL is grounded in their potential to promote active engagement, problem analysis, repeated practice, and team collaboration, which are expected to comprehensively enhance both self-efficacy and psychomotor skills (Prabowo et al., 2025). The theoretical contribution of this study lies in extending Albert Bandura's Self-Efficacy Theory by examining how these two distinct learning models (PBL and PjBL) mediate mastery and vicarious experiences in developing students' self-efficacy, as well as how self-efficacy interacts with the learning model to influence psychomotor performance within a dynamic game-based learning environment. The findings are expected to provide practical guidance for educators and offer richer conceptual insights into the interactions between cognition, affect, and the psychomotor domain in motor learning.

Materials and methods

Study participants

The population of this study consisted of students from Senior High School 1 Tasikmalaya. The inclusion criteria were: aged 15-16 years, having good physical health with no history of chronic injury, voluntary participation with signed informed consent, and not being an active athlete to minimize baseline performance bias. The exclusion criteria were: sustaining a physical injury during or throughout the study, voluntary withdrawal from the study at any time, and absence in more than three intervention sessions.

Thus, the sample comprised 40 students, consisting of 20 males and 20 females. The characteristics of the male students were (mean $\pm$ SD): age 15.7 ± 3.9 years, height 164.7 ± 7.2 cm, and weight 59.4 ± 2.2 kg. Meanwhile, the female students had the following characteristics: age 15.5 ± 7.1 years, height 160.3 ± 2.5 cm, and weight 53.1 ± 0.6 kg.

Study organization

This study employed an experimental design, specifically a two-group pretest-posttest design using a 2×2 factorial method. The study adopted a comparative approach between two innovative pedagogical models (PBL and PjBL), without including a control group representing conventional instruction or no intervention. This approach was selected because the research aimed to analyze and compare the effects of two active interventions that are both believed to have positive potential in adolescent physical education. By comparing these innovative models, the study sought to identify which model is more optimal in this specific context. Additionally, this design enables meaningful inferences about the comparative effectiveness

and underlying mechanisms of each model, rather than merely measuring change from a non-intervention baseline.

A total of 40 students were assigned to two intervention groups (20 students each) based on their ranked pretest self-efficacy scores, using the ordinal pairing method (A-B-B-A) to ensure balanced initial abilities across groups (Mulya et al., 2025). Students were then classified into “high” and “low” self-efficacy categories using a median-split technique from validated self-efficacy questionnaire scores. Students scoring above the median were categorized as having high self-efficacy, whereas those scoring below or equal to the median were categorized as having low self-efficacy. Consequently, the group divisions in this study were: A1B1 (PBL with high self-efficacy), A1B2 (PBL with low self-efficacy), A2B1 (PjBL with high self-efficacy), and A2B2 (PjBL with low self-efficacy).

All data collection and intervention procedures were conducted at Siliwangi University to ensure proper supervision. This study received ethical clearance under approval number 05/UN58.10/PT/2025.

PBL and PjBL Intervention Using Big Ball Games

The PBL and PjBL intervention programs were conducted over six weeks (18 sessions), with sessions held weekly on Monday, Wednesday, and Friday. Each session lasted 90 minutes, consisting of 10 minutes for instruction and warm-up, 10 minutes for cooldown and evaluation, and 70 minutes for core activities. The intensity of each session was maintained between 65%-75% to ensure students’ enjoyment and physical fitness while avoiding stress and fatigue. Heart rate intensity was monitored using the rating of perceived exertion (RPE), targeting a moderate level (12-14) (Chowdhury et al., 2019).

Table 1. Problem-Based Learning (PBL) Program

Meeting	Problem	Material	Target
Week 1	How can a team effectively control and pass the ball among teammates under pressure to maintain ball possession and create scoring opportunities?	Football: Short passing and dribbling with ball control.	1) Improve accuracy and control in passing and dribbling in both static and dynamic situations.
		Basketball: Chest pass, bounce pass, controlled dribble and speed dribble while moving.	2) Develop awareness of teammates’ and opponents’ positions.
Week 2	How can a team effectively create and utilize space to move into attacking positions and	Volleyball: Forearm pass (passing to a target) to build an attack.	3) Facilitate effective communication during ball movement.
		Football: Shooting, off-ball movement to create space.	4) Analyze and identify common challenges in maintaining ball possession under pressure.
			5) Develop tactical solutions to overcome defensive pressure during passing and dribbling.
			1) Develop offensive movement strategies to create space.
			2) Improve shot/smash accuracy and power.

	execute successful shots/attacks?	Basketball: Lay-up, jump shot, cutting to find space. Volleyball: Attacking spike and setting (assisting the spiker).	3) Enhance timing and coordination in offensive play. 4) Analyze how space is created and used for attacks. 5) Design and implement drills focused on moving into open space and completing attacks.
Week 3	How can a team effectively defend against opponents, prevent scoring, and regain ball possession across different ball sports?	Football: Blocking, marking, intercepting passes. Basketball: Defensive stance, man-to-man guarding, blocking shots, rebounding. Volleyball: Blocking (single/double block), defensive digging/receiving.	1) Improve defensive positioning and movement. 2) Enhance anticipation and reaction time for interceptions. 3) Develop safe and effective defensive techniques. 4) Analyze failures and successes of defensive strategies in ball games. 5) Identify key defensive principles (e.g., man-to-man, zone) and apply them.
Week 4	How can a team quickly transition from defense to attack and vice versa to surprise the opponent and exploit their weaknesses?	Football: Quick turnovers, long passes, counterattack runs. Basketball: Fast break, transition defense. Volleyball: Transition from defense to attack (dig, set, spike).	1) Improve speed and efficiency in offensive and defensive transitions. 2) Enhance decision-making under time pressure. 3) Develop coordinated team movements during transitions. 4) Analyze examples of fast counterattacks and identify their key principles. 5) Design mini-games focusing on rapid change of possession and counterattacks.
Week 5	How can a team design and execute effective set pieces (e.g., corner kicks, free throws, serves) to gain an advantage in critical game situations?	Football: Corner kicks, free kicks, throw-ins. Basketball: Inbound plays, free throw shooting. Volleyball: Serve (underhand/overhand), service reception.	1) Develop accurate and powerful execution of set pieces. 2) Improve strategic understanding and coordination during set plays. 3) Enhance focus and composure in critical moments. 4) Analyze successful set pieces from professional matches. 5) Brainstorm and design students' own set plays.

Week 6	How can a team integrate all previously learned skills and strategies, adapt to changing game conditions, and demonstrate effective teamwork to achieve game objectives?	Movement Indicator: Application of all learned basic techniques and strategies in dynamic and complex game situations. Performance Indicator: Overall game performance, decision-making, real-time problem-solving, teamwork, and ability to adapt to changing situations.	1) Apply and integrate all fundamental skills and strategies in complex gameplay scenarios. 2) Improve tactical awareness and adaptability. 3) Enhance team cohesion and overall performance. 4) Participate in full-scale mini-games with varied rules or conditions (e.g., man advantage/disadvantage, specific scoring systems). 5) Reflect on performance, identify areas for improvement, and adjust strategies in real time.
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Table 2. Project-Based Learning (PjBL) Program

Meeting	Project	Material	Target
Week 1	Ball Mastery & Passing Accuracy Challenge	Football: Dribbling, short and accurate passing to target Basketball: Dribbling, chest pass, and bounce pass to a moving target Volleyball: Forearm pass with directional control and power to a specific target, basic self-setting or partner-setting	1) Students can demonstrate good ball control during dribbling in various situations. 2) Students can perform accurate and powerful passing (football/basketball/volleyball) toward static and moving targets. 3) Students can design effective drills to train ball control and passing skills. 4) Develop self-efficacy through successful experiences in designing and executing their own challenges. 5) Improve teamwork in planning and evaluating activities.
Week 2	Offensive Playbook & Execution Showcase	Football: Shooting at the goal, off-the-ball movements to create space, wall pass Basketball: Lay-up, jump shot from different positions, cutting and screening	1) Students are able to design cohesive and effective offensive plays. 2) Students can execute shooting (football/basketball) or spiking (volleyball) with power and accuracy in game contexts.

		Volleyball: Attacking spike, setting for spikers, 2-3 touch attack strategies	3) Students demonstrate understanding of off-the-ball movement and space creation. 4) Improve presentation and tactical explanation skills. 5) Build self-efficacy through successful demonstrations and constructive feedback.
Week 3	Defensive Wall & Counter-Attack Blueprint	Football: Blocking, marking opponents, intercepting passes, quick transition from defense to attack Basketball: Defensive stance and footwork, on-ball and off-ball guarding, rebounding, transition to fast break Volleyball: Blocking (single/double), digging (receiving attacks), transition from defense to attack setup	1) Students can apply effective defensive positioning. 2) Students can perform guarding, blocking, or digging using correct and safe techniques. 3) Students show the ability to regain ball possession and transition quickly into offense. 4) Develop analytical skills in designing defensive and counter-attack strategies. 5) Enhance self-efficacy through successful implementation of defensive and counter-attack plans.
Week 4	Game Situation Mastery: Adapting Strategies Under Pressure	Football: Dribbling in tight spaces, passing under pressure, shooting from unfavorable positions, defending when outnumbered Basketball: Dribbling and passing under full-court press, shooting under heavy defense, defending with man down Volleyball: Handling difficult passes and sets (out-of-system), receiving strong serves, defending against fast attacks	1) Students can quickly adapt to changing game situations. 2) Students can maintain control and accuracy of fundamental skills under pressure. 3) Students demonstrate quick and accurate decision-making. 4) Strengthen self-efficacy when facing unexpected challenges. 5) Promote higher levels of communication and teamwork to solve problems during gameplay.
Week 5	Ultimate Team Challenge: Multidisciplinary Big Ball Games	Football: Application of all basic techniques (dribbling, passing, shooting, blocking) in a mini-match scenario	1) Students can integrate and apply various fundamental skills from the three Big Ball sports effectively.

		Basketball: Application of all basic techniques (dribbling, passing, shooting, defense, rebounding) in a mini-match scenario	2) Students demonstrate adaptability and transitions across different sports.
		Volleyball: Application of all basic techniques (passing, setting, smashing, blocking, serving, digging) in a mini-match scenario	3) Develop broader tactical understanding and teamwork in a multidisciplinary context. 4) Improve self-efficacy through completing complex challenges involving multiple skills. 5) Encourage creativity in developing strategies for hybrid games.
Week 6	Big Ball Sports Skills & Tactics Showcase: Performance and Reflection	Consolidation: Application of all fundamental techniques and strategies learned from Week 1-5 in a match or skill-exhibition format. Self-Evaluation: Reflection on individual and team skill development.	1) Students can demonstrate mastery and integration of trained psychomotor skills. 2) Students show the ability to collaborate and communicate effectively in match situations. 3) Students can reflect on their learning process and identify areas for future development. 4) Strengthen self-efficacy through completion of a final project and recognition of their effort. 5) Improve organizational, presentation, and self-assessment skills.

Research Instrument

The instruments used in this study were developed during the third phase of the research. The self-efficacy variable adapted the Endurance Sport Self-Efficacy Scale (ESSES) developed by [Anstiss et al., \(2018\)](#). This scale consists of 11 statement items, using a 1-4 Likert scale. The ESSES has also been validated among participants aged 15-18 years from two provinces in Indonesia ([Saniah et al., 2024](#)). The psychomotor test variable was adapted from the Test of Gross Motor Development-3 (TGMD-3). The TGMD-3 evaluates motor performance using ball-based assessments, consisting of the following seven test types: 1) Forehand strike of self-bounced ball; 2) One-hand stationary dribble; 3) Two-hand catch; 4) Kick a stationary ball; 5) Overhand throw; 6) Underhand throw; 7) Two-hand strike of a stationary ball ([Magistro et al., 2020](#); [Valentini et al., 2022](#)).

The TGMD-3 assessment was conducted through direct observation by two qualified examiners, both holding a Doctoral degree. The selection of these examiners aimed to prevent potential bias by ensuring high competence and independence from any student or teacher at the school. Inter-rater reliability for all seven psychomotor tests (TGMD-3) was assessed using the Intraclass Correlation Coefficient (ICC) (two-way mixed model, absolute agreement) based on pretest scores.

A 0-4 scoring system was implemented. Therefore, a detailed scoring rubric was developed to guide the examiners in decision-making. The rubric used in this assessment is presented below:

Table 3. Assessment Rubric on TGMD-3

Test Type	Score	Description
Forehand strike of self-bounced ball	4	Student bounces a ball and performs a forehand strike using correct technique (pivot, weight transfer, follow-through); the ball is accurately directed to the target without correction, in a single attempt.
	3	Most technical elements are achieved (pivot/weight transfer/follow-through); the ball is mostly accurate but shows minor errors (e.g., slight correction or suboptimal direction).
	2	Technique is less stable (lack of pivot or follow-through); ball occasionally misses or requires correction.
	1	Technique is unstable (minimal pivot, weak weight transfer, limited follow-through); frequent misdirection.
	0	Strike is incorrect, target is missed, or task is not completed.
One-hand stationary dribble	4	Student dribbles with one hand without moving feet, demonstrating stable control and completing target repetitions with minimal errors.
	3	Good control with one or two minor errors (e.g., slight bounce or misdirection), feet mostly remain stationary.
	2	Inconsistent control (ball bounces too high or feet move); some pauses or corrections occur.
	1	Frequent loss of control, unstable feet movement, repetitions not smooth.
	0	Unable to perform proper dribbling or fails to complete the task.
Two-hand catch	4	Student catches the ball using both hands, with proper body position and full control, without bouncing or loss of control.
	3	Most elements are present; one or two minor control issues, but overall successful.
	2	Several unstable catches, minor bounce or delayed readiness, but most attempts are successful.
	1	Frequent failure to catch or maintain control; poor readiness and body position.
	0	Unable to meet criteria or fails consistently.
Kick a stationary ball	4	Student kicks a stationary ball using the preferred foot and instep (or per instructions), with accurate direction and proper stance/follow-through.
	3	Direction is mostly correct; technique is reasonably good with minor weaknesses.
	2	Direction occasionally misses; technique incomplete (e.g., unstable stance or weak follow-through), but still completes the task.
	1	Major errors in direction and control; poor stance and follow-through, difficult tasks completed to standard.
	0	The kick is too far from the target or fails to complete as instructed.
Overhand throw	4	The student performs an overhand throw with proper readiness posture, stable foot pivot, full body rotation, and appropriate

		follow-through. The ball reaches the target with good control and adequate force.
	3	Most techniques are correctly demonstrated; one or two minor elements may be lacking (e.g., slight posture or follow-through issues), but the task is successfully completed.
	2	Technique is acceptable, but several key aspects are lacking (e.g., weak body rotation, limited follow-through, or slightly inaccurate direction). The task is still completed.
	1	Multiple technical errors occur (improper posture, unstable foot pivot, weak follow-through). Control and direction are poor, and the outcome is far from the target.
	0	The throw does not meet the task criteria and fails to reach the target appropriately.
Underhand throw	4	The student performs an underhand throw with stable foot placement, smooth arm swing, and controlled follow-through toward the target. The ball is accurately directed with good control.
	3	Technique is mostly correct; one or two elements are not fully optimal but the result is almost accurate.
	2	Several technical weaknesses are observed (e.g., weak foot pivot, insufficient arm swing). The direction/control is slightly off, but the task is completed.
	1	Many technical mistakes are present, resulting in poor control and direction. The outcome is far from the target.
	0	The student does not meet the criteria or the result is significantly below the expected standard.
Two-hand strike of a stationary ball	4	The student strikes a stationary ball with both hands using correct technique (body position, foot placement, full swing), sending the ball toward the target with good power and control.
	3	Technique is mostly correct; there may be a slight lack of power or a minor weakness in follow-through, but direction and outcome are adequate.
	2	Several aspects of technique are lacking (e.g., foot pivot, swing, or follow-through). The direction is slightly off or control is limited, but the task is completed.
	1	Multiple technical errors occur; direction and control are poor, resulting in a suboptimal outcome.
	0	The task is not completed correctly, with significant errors or failure to strike the ball toward the target.

The score was determined through agreement between Examiner 1 and Examiner 2, using side-by-side comparison of performance and rubric descriptors to maintain scoring consistency. A review of video recordings was strongly recommended to improve scoring accuracy. Equipment used for the psychomotor assessment included: tennis balls, size-5 basketballs, lightweight plastic balls, size 4/5 football balls, plastic bats, cones, tape for marking distances, targets (mini goals, rings, baskets), a stopwatch, and a camera to record all tests.

Statistical analysis

Data analysis began with reliability testing using Cronbach's alpha, referencing a reliability threshold of >0.70 (Bujang et al., 2018), and Intraclass Correlation Coefficient (ICC)

for the seven TGMD-3 psychomotor items. This step aimed to ensure that all instruments were dependable for use in the study. Next, normality and homogeneity tests were conducted.

To address the research objectives, data were analyzed using Multivariate Analysis of Covariance (MANCOVA). MANCOVA was selected to simultaneously examine the effects of two independent variables, learning model (PBL vs. PjBL) and self-efficacy level (high vs. low), on multiple dependent variables, while controlling for the covariate (self-efficacy pretest scores). The use of a covariate aimed to enhance statistical power and reduce irrelevant variance from pre-existing group differences. All statistical analyses were conducted using SPSS version 27 (George & Mallery, 2021).

Results

The analysis of the research findings began with testing the instrument reliability before conducting the MANCOVA analysis. This step aimed to determine the level of reliability of the instruments used in this study. The self-efficacy questionnaire was analyzed using Cronbach's alpha, while the seven psychomotor test items were assessed using the Intraclass Correlation Coefficient (ICC). Reliability analysis was performed using pretest data, as it reflects the students' initial abilities prior to the intervention.

For the self-efficacy variable, the reliability results are explained narratively. The Cronbach's alpha reliability test, with 11 statement items, yielded a value of $\alpha = 0.804$, indicating a high level of reliability for the Endurance Sport Self-Efficacy Scale (ESSES) instrument.

Meanwhile, reliability testing for the seven psychomotor test items was conducted using ICC. This analysis was essential because the psychomotor tests in this study were assessed by more than one rater, thus requiring ICC to ensure inter-rater consistency. The results of the ICC analysis based on students' pretest data are presented in Table 4.

Table 4. ICC Results on TGMD-3

Psychomotor Test	ICC Single Measures	CI 95% (LB - UB)	ICC Average Measures	CI 95% (LB - UB)	Sig.
Forehand Strike of Self-Bounced Ball	0.622	0.701 - 0.798	0.877	0.827 - 0.899	0.019
One-Hand Stationary Dribble	0.619	0.753 - 0.808	0.835	0.821 - 0.890	0.012
Two-Hand Catch	0.603	0.746 - 0.811	0.825	0.831 - 0.919	0.011
Kick a Stationary Ball	0.668	0.761 - 0.873	0.859	0.831 - 0.942	0.008
Overhand Throw	0.626	0.738 - 0.822	0.847	0.831 - 0.895	0.010
Underhand Throw	0.648	0.725 - 0.863	0.868	0.788 - 0.901	0.009
Two-Hand Strike of a Stationary Ball	0.628	0.703 - 0.812	0.828	0.735 - 0.898	0.016

Based on the results presented in Table 4, the ICC Single Measures values for the psychomotor items ranged from 0.603 to 0.668, indicating moderate reliability, while the ICC Average Measures ranged from 0.825 to 0.877, reflecting good reliability. Furthermore, all

psychomotor test items showed $p < 0.05$, indicating that the reliability of each test was statistically significant (Martínez Pérez & Pérez Martín, 2023).

After confirming that the instruments demonstrated acceptable reliability to be used for data collection in this study, they were subsequently employed to obtain the pretest and posttest data. Once all data were collected, the next step, prior to conducting the MANCOVA analysis, was to perform the normality test and homogeneity test, the results of which are presented in Table 5.

Table 5. Normality and Homogeneity Tests Results

Variable	Kolmogorov-Smirnov			Levene's Test			
	Statistic	df	Sig.	F	df1	df2	Sig.
Self-Efficacy Pretest	0.096	40	0.200	0.738	7	32	0.638
Psychomotor Pretest	0.113	40	0.200	0.438	7	32	0.452
Self-Efficacy Posttest	0.117	40	0.082	0.563	7	32	0.780
Psychomotor Posttest	0.098	40	0.078	0.744	7	32	0.637

Based on the results in Table 5, the Kolmogorov–Smirnov test showed that all variables met the assumption of normality: self-efficacy pretest ($0.200 > 0.05$), psychomotor pretest ($0.200 > 0.05$), self-efficacy posttest ($0.082 > 0.05$), and psychomotor posttest ($0.078 > 0.05$). Meanwhile, the Levene test results also indicated homogeneity across all variables: self-efficacy pretest ($0.638 > 0.05$), psychomotor pretest ($0.452 > 0.05$), self-efficacy posttest ($0.780 > 0.05$), and psychomotor posttest ($0.637 > 0.05$). Therefore, the overall data in this study were normally distributed and derived from a homogeneous population, as all values exceeded the threshold of 0.05.

Subsequently, the MANCOVA analysis in this study proceeded to examine the Multivariate Test results, which evaluate whether a factor or covariate exerts a simultaneous effect on two dependent variables (self-efficacy and psychomotor posttests). The interpretation of the MANCOVA results referred to the Pillai's Trace value, as this approach is recommended for studies with a relatively small sample size (Mertler et al., 2021). The complete results of the Multivariate Tests are presented in Table 6.

Table 6. Multivariate Results of MANCOVA Using Pillai's Trace

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Intercept	Pillai's Trace	0.584	20.362	2.000	29.000	0.000	0.584
Self_Efficacy_Pre test	Pillai's Trace	0.359	8.131	2.000	29.000	0.002	0.359
Psychomotor_Pre test	Pillai's Trace	0.208	3.801	2.000	29.000	0.034	0.208
Group	Pillai's Trace	0.380	2,348	6.000	60.000	0.042	0.190
Gender	Pillai's Trace	0.197	3.562	2.000	29.000	0.041	0.197
Group * Gender	Pillai's Trace	0.103	0.545	6.000	60.000	0.772	0.052

Based on the results shown in Table 6, it was found that the self-efficacy pretest had a significant multivariate effect on both dependent variables, with Pillai's Trace = 0.359; $F = 8.131$; $p = 0.002$; Partial $\eta^2 = 0.359$. Similarly, psychomotor pretest scores exhibited a significant multivariate effect on the two dependent variables, with Pillai's Trace = 0.208; $F = 3.801$; $p = 0.034$; Partial $\eta^2 = 0.208$. Furthermore, there was a significant multivariate difference between the treatment groups ($F = 2.348$; $p = 0.042$). Gender also showed a significant multivariate effect on both dependent variables ($F = 3.562$; $p = 0.041$). However, no significant interaction was found between treatment groups and gender, as indicated by the value $F = 0.545$; $p = 0.772$.

The next part of the MANCOVA report examines the Tests of Between-Subjects Effects, focusing specifically on self-efficacy posttest and psychomotor posttest performance, as presented in Table 7.

Table 7. Statistical Analysis of Self-Efficacy and Psychomotor Posttest

Source		df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	Self-Efficacy Posttest	9	31.345	2.397	0.035	0.418
	Psychomotor Posttest	9	46.723	4.465	0.001	0.573
Intercept	Self-Efficacy Posttest	1	98.729	7.550	0.010	0.201
	Psychomotor Posttest	1	435.850	41.655	0.000	0.581
Self_Efficacy_Pretest	Self-Efficacy Posttest	1	85.972	6.575	0.016	0.180
	Psychomotor Posttest	1	50.369	4.814	0.036	0.138
Psychomotor_Pretest	Self-Efficacy Posttest	1	70.530	5.394	0.027	0.152
	Psychomotor Posttest	1	52.553	5.023	0.033	0.143
Group	Self-Efficacy Posttest	3	14.731	1.127	0.354	0.101
	Psychomotor Posttest	3	53.066	5.072	0.006	0.337
Gender	Self-Efficacy Posttest	1	2.826	0.216	0.645	0.007
	Psychomotor Posttest	1	59.178	5.656	0.024	0.159
Group * Gender	Self-Efficacy Posttest	3	8.641	0.661	0.583	0.062

Psychomotor Posttest	3	3.307	0.316	0.814	0.031
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Based on the results in Table 7, the initial level of self-efficacy (pretest) had a significant effect on the final self-efficacy (posttest) (sig. = 0.016). The psychomotor pretest also showed a significant effect; therefore, students with higher initial motor skills tended to experience an increase in self-efficacy (sig. = 0.027). The learning models (PBL and PjBL) did not produce a significant difference in posttest self-efficacy (sig. = 0.354). Gender did not affect self-efficacy (sig. = 0.645), and no interaction was found between group and gender (sig. = 0.661).

Psychomotor pretest significantly affected students' posttest psychomotor performance (sig. = 0.036). The psychomotor pretest also significantly influenced posttest psychomotor outcomes (sig. = 0.033). The treatment groups (PBL vs. PjBL) showed a significant effect on psychomotor performance (sig. = 0.006). Gender also influenced psychomotor outcomes (sig. = 0.024), while no interaction was found between group and gender (sig. = 0.316). Furthermore, this study reports the Estimated Marginal Means based on group and gender, as the estimates represent adjusted mean values after controlling for the covariates. Table 8 below presents the estimated values from the MANCOVA analysis.

Table 8. Results on Estimated Marginal Means

Dependent Variable		Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Posttest Self-Efficacy	A1B1	88.132	1.152	85.779	90.485
	A1B2	89.596	1.394	86.749	92.444
	A2B1	91.337	1.317	88.648	94.026
	A2B2	89.734	1.197	87.290	92.178
	Male	89.434	0.809	87.781	91.087
	Female	89.966	0.809	88.313	91.619
Posttest Psychomotor	A1B1	89.279	1.031	87.174	91.384
	A1B2	89.388	1.247	86.841	91.935
	A2B1	94.858	1.178	92.452	97.264
	A2B2	93.675	1.070	91.489	95.861
	Male	93.019	0.724	91.540	94.497
	Female	90.581	0.724	89.103	92.060

Based on Table 8, the estimated marginal mean for post-intervention self-efficacy was as follows: A1B1 showed a score of 88.13 (SE = 1.15; 95% CI = 85.78–90.49), A1B2 showed 89.60 (SE = 1.39; 95% CI = 86.75–92.44), A2B1 showed 91.37 (SE = 1.32; 95% CI = 88.65–94.03), and A2B2 showed 89.73 (SE = 1.20; 95% CI = 87.29–92.18). Although A2B1 demonstrated the highest mean score, the analysis indicated that the differences between groups were not significant in relation to post-intervention self-efficacy. The post-intervention self-efficacy scores of male students (EMM = 89.43; SE = 0.81; 95% CI = 87.78–91.09) and female students (EMM = 89.97; SE = 0.81; 95% CI = 88.31–91.62) were nearly identical.

For post-intervention psychomotor skills, A1B1 showed a score of 89.28 (SE = 1.03; 95% CI = 87.17–91.38), A1B2 showed 89.39 (SE = 1.25; 95% CI = 86.84–91.94), A2B1 showed 94.86 (SE = 1.18; 95% CI = 92.45–97.26), and A2B2 showed 93.68 (SE = 1.07; 95% CI = 91.49–95.86). The PjBL group (A2B1) demonstrated the highest improvement in psychomotor skills compared to the other groups. Male students obtained an EMM of 93.02 (SE = 0.72; 95% CI = 91.54–94.50), which was higher than female students who obtained an EMM of 90.58 (SE = 0.72; 95% CI = 89.10–92.06).

Discussion

The initial findings of this study reveal that the self-efficacy pretest and the psychomotor performance pretest had a significant multivariate effect on both dependent variables. This underscores the importance of students' initial conditions as strong predictors of learning outcomes. Previous studies have shown that early sport experience and perceived self-efficacy at a young age are critical factors influencing long-term developmental pathways and sport participation (Reverdito et al., 2023). In addition, other researchers have emphasized that a comprehensive assessment of fundamental motor skills is essential for identifying deficits and monitoring developmental progress (Suresh & Subash, 2023). A stronger foundation in basic motor skills at the beginning of an intervention provides greater stability for mastering more complex skills. From a motor learning perspective, students who enter an intervention with more established movement patterns may require fewer cognitive resources to organize basic actions, allowing them to focus more effectively on tactical decisions, movement adaptation, and skill refinement. Therefore, baseline assessment is not merely a statistical requirement but also an important pedagogical basis for determining the level of task complexity and instructional support required by each student.

Regarding post-intervention self-efficacy, both self-efficacy and psychomotor performance pretests significantly influenced the final self-efficacy scores. Students with higher initial motor skills tended to show greater improvements in self-efficacy. This reinforces Bandura's theoretical perspective that mastery experiences serve as the most powerful source of self-efficacy formation (Kreutz et al., 2023; X. Li et al., 2024). When students possess a solid foundation of motor ability, they are more likely to experience success in physical activities, thereby increasing their confidence in their capabilities. A study by Li et al., (2024) further supports this notion, demonstrating that physical activity enhances resilience through the indirect effects of self-efficacy and basic psychological needs. The relationship may also operate reciprocally: stronger initial motor competence creates more opportunities for successful performance, while stronger self-efficacy encourages persistence, task engagement, and willingness to repeat difficult movements (Agustriyani et al., 2026). Nevertheless, the significant covariate effects identified in this study should be interpreted as predictive associations rather than direct evidence of a causal mechanism between baseline motor competence and changes in self-efficacy.

However, another key finding indicates that PBL and PjBL did not produce a significant difference in final self-efficacy. Despite this, the estimated marginal means revealed that the PjBL group with high self-efficacy (A2B1) menunjukkan rata-rata tertinggi. It suggests that both models, when implemented through Big Ball sports, are equally effective in maintaining or enhancing students' self-efficacy. Prior evidence indicates that PBL can increase learning interest and effectiveness through active involvement of students (Liu et al., 2023), as well as promote problem-solving skills and group collaboration (H. Li et al., 2022). Meanwhile, PjBL, as a project-driven approach, encourages motivation and collaboration, indirectly contributing to the development of self-efficacy (Elumalai et al., 2022 ; Nafiâ et al., 2022). The active and participatory learning environment provided by both models, particularly within Big Ball game contexts, may offer sufficient mastery and vicarious learning experiences to build self-efficacy evenly among students. This result is further supported by scientific evidence indicating that self-efficacy is not influenced by students' socioeconomic status in the context of digital games (Arztmann et al., 2024). Moreover, immersive and motivating learning environments can help mitigate differences related to students' socioeconomic background. Additional findings also demonstrate the role of game-based learning in enhancing self-efficacy through creativity (Ting & Yeh, 2024).

The superiority of PjBL in enhancing psychomotor skills can be explained by several intrinsic characteristics of the model. PjBL emphasizes long-term, authentic projects that often

involve complex applications, repeated practice, and problem-solving in real-world contexts (Elumalai et al., 2022; Nafiâ et al., 2022). Within Big Ball sports, students engage continuously in gameplay situations that demand integrated mastery of basic techniques and tactical decisions. A study by Hardinata et al., (2023) directly showed that PjBL improved dribbling skills in football, a fundamental psychomotor skill. Another PjBL-based approach successfully enhanced physical education students' ability to organize wrestling competitions, which required a range of practical and complex coordination skills (Bafadal & Haetami, 2021). The PjBL learning environment enables students to experience repeated cycles of planning, execution, evaluation, and refinement, elements that are highly conducive to consolidating and refining motor skills.

In contrast, although PBL is effective in improving cognitive and motivational aspects, its core focus lies more in problem analysis and conceptual solutions (H. Li et al., 2022; Liu et al., 2023). Although PBL has been shown to improve basic movement skills in elementary school students (Alazzraq et al., 2022), for mastering complex psychomotor skills among adolescents aged 15-16 years in Big Ball sports, a more structured and repetitive physical practice may be more advantageous. In the present intervention, PBL required students to analyze tactical problems, discuss possible solutions, and apply them in game situations. Although these processes can strengthen decision-making and tactical awareness, part of the available learning time may have been devoted to problem identification and discussion rather than to repeated execution and refinement of specific motor techniques (Prabowo et al., 2025). Big Ball games inherently involve demanding psychomotor activities, such as small-sided games that promote physical fitness and motor skill learning (Li et al., 2024), and other studies have linked coordination-based motor skills with individual football performance effectiveness (Bojkowski et al., 2022). Further innovations in Big Ball learning, such as the use of online media (Amran et al., 2023) and modified volleyball practices, have also demonstrated potential for improving motor skills through tailored practice (Nugroho et al., 2022).

Furthermore, the analysis revealed that gender significantly influenced psychomotor outcomes. This finding aligns with numerous studies in physical education that report performance differences between males and females, particularly in sports requiring strength, speed, and endurance (da Costa et al., 2023). These differences may be explained by biological factors such as body composition and hormonal profiles, as well as sociocultural influences that lead to variations in prior sport participation or preferred types of physical activities (Santoso et al., 2024). In the present sample, male students obtained higher adjusted psychomotor scores than female students; however, this finding should not be generalized as evidence of an inherent difference in learning capacity. Previous sport experience, frequency of participation in Big Ball games, access to practice opportunities, and familiarity with the test tasks were not comprehensively controlled and may have contributed to the observed difference (Afifah et al., 2024). Nevertheless, the absence of interaction effects between gender and learning models suggests that both PBL and PjBL can be adapted to provide psychomotor benefits to all students.

The findings of this study offer practical implications for curriculum development and teaching practices in physical education, particularly at the secondary school level. A key priority is for physical education teachers to consider implementing PjBL more extensively in Big Ball sports instruction, as it has been shown to be more effective in enhancing psychomotor skills among students aged 15-16 years. Although both PBL and PjBL positively contribute to self-efficacy, the superior impact of PjBL in the psychomotor domain highlights its benefits for long-term projects, practical application, and repeated hands-on experiences, especially for mastering complex motor skills. Teachers may design projects that require students to develop gameplay strategies, consistently practice fundamental techniques, and collaborate in simulated match scenarios. Moreover, although gender-based differences in psychomotor outcomes were

observed, the absence of interaction with learning models implies that both models can be tailored effectively for all students.

This study has several limitations, including a relatively small sample size and the involvement of only one school, which may restrict the generalizability of the findings. Additionally, although the intervention duration of 18 sessions was adequate, it may not fully capture the long-term effects of the learning models on self-efficacy and psychomotor skills. Other potentially influential variables, such as intrinsic motivation or learning satisfaction, were not extensively measured. Therefore, future research should involve larger and more diverse samples, extend the intervention duration, and consider additional moderator or mediator variables such as intrinsic motivation, learning satisfaction, or more detailed gender-based categorization. Comparative studies including a control group with traditional approaches or no intervention would also provide a deeper understanding of the relative effectiveness of PBL and PjBL.

Conclusions

Baseline self-efficacy and psychomotor skills were significantly associated with students adjusted post-intervention outcomes, confirming that initial psychological beliefs and motor competence are important considerations in physical education learning. No significant difference was found between the PBL and PjBL groups in adjusted post-intervention self-efficacy; therefore, the findings indicate comparable self-efficacy outcomes rather than statistical equivalence or definitive evidence that both models produced the same degree of improvement. In contrast, the PjBL groups obtained higher adjusted psychomotor scores than the PBL groups, indicating that sustained projects involving planning, repeated authentic practice, feedback, performance evaluation, and refinement may provide a more supportive environment for developing complex ball-related motor skills. The scientific contribution of this study lies in demonstrating that active learning models may produce different patterns of psychological and psychomotor outcomes when implemented through integrated Big Ball games among students aged 15–16 years. Practically, physical education teachers may prioritize PjBL when psychomotor development is the primary instructional objective while using differentiated tasks to accommodate students' initial self-efficacy levels. The higher psychomotor scores observed among male students should be interpreted only within this sample because previous sport experience and practice opportunities were not comprehensively controlled. These conclusions are limited by the small single-school sample, six-week intervention, absence of a conventional control group and retention test, median-based self-efficacy classification, and use of adapted instruments. Future studies should employ larger multisite samples, longer interventions, direct factorial and pairwise analyses, follow-up assessments, and measurements of practice volume, feedback, motivation, mastery experiences, and intervention fidelity.

Acknowledgment

The author would like to thank Siliwangi University for providing facilities and supporting the research up to publication.

Conflict of interest

The authors declare that they have no conflicts of interest.

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Information about the authors:

Dr. Defri Mulyana, M.Pd: defrimulyana@unsil.ac.id, <https://orcid.org/0009-0005-2356-6829>, Department of Physical Education, Universitas Siliwangi, Tasikmalaya, Indonesia.

Prof. Dr. Komarudin, M.Pd: komarudin_pko@upi.edu, <https://orcid.org/0000-0002-3058-2633>, Department of Sport Education, Universitas Pendidikan Indonesia, Bandung, Indonesia.

Dr. Nevitaningrum, M.Pd: nevitaningrum@unsil.ac.id, <https://orcid.org/0009-0004-5953-3714>; Department of Physical Education, Universitas Siliwangi, Tasikmalaya, Indonesia.

Dr. Trisnar Adi Prabowo, M.Pd: trisnar.prabowo@umbs.ac.id, <https://orcid.org/0000-0001-6977-0503>; Departement of Physical Education, Universitas Muhammadiyah Brebes.

Cite this article as:

Mulyana, D. et al. (2026). The Implementation of Big Ball Game-Based Learning Models on Psychomotor Skills Across Self-Efficacy Levels in Students Aged 15-16 Years. *Indonesian Journal of Physical Education and Sport Science (IJPESS)*, 6(3), 414-434. <https://doi.org/10.52188/ijpess.v6i3.2236>