

Designing a Learning-Based Warming-Up Model for Football Courses

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Abstract Football requires mastery of fundamental skills that are not only obtained through core training but also through effective warming up. However, warm-up activities used in learning are often conventional and lack integration with course materials. This study aimed to develop a learning-based football warm-up model using the ball as the main medium, providing physiological, technical, and psychological benefits simultaneously. This research employed a Research and Development (R&D) approach, modified from Borg and Gall's steps into five stages: information gathering, product design, expert validation, small-scale field testing, and large-scale field testing. The subjects were physical education students, consisting of 30 participants in the small-scale trial and 100 participants in the large-scale trial. The instrument used was a basic football skill test by Nusri et al. (2022). The developed warm-up model consisted of 36 activities grouped into five components: ball feeling, passing, dribbling, shooting, and heading. Paired Samples T-Test analysis on five variables (np, nr, nd, nlp, and n_bp) showed significant differences between pretest and posttest scores ($p < 0.01$). This indicates that the developed warm-up model effectively improved students' fundamental football skills and cardiovascular endurance. The developed warm-up model is proven to be relevant to support learning outcomes in basic football skills and can serve as an innovative alternative in sports courses.

Keywords Warm-Up, Football, Learning, Technique, VO₂max

1. Introduction

Football is one of the most popular sports worldwide and is played in almost every country. Several nations have even integrated it into their educational systems as a subject or course, such as Indonesia, China [1], Germany [2], India [3], and others. In Indonesia, football education begins at an early age, supported by the large number of Football Schools (SSB) or Football Academies spread across the country. The establishment of these football education institutions aims to enhance football achievements by nurturing individuals from a young age. Through early and continuous training, talented young players can develop their skills effectively by receiving proper guidance that balances both theoretical understanding and practical application on the field [4]. This foundational approach guides students to improve their technical skills in football from an early stage.

However, mastering football techniques alone is not sufficient in training. Various supporting aspects are required to enhance performance—one of the most essential being warming up, which plays a crucial role in preparing players both physically and mentally before engaging in core training or competition. Studies have shown that warming up can increase physical performance by up to 79% [5] and even reduce the risk of injury [6,7]. From a technical perspective, warm-up activities have been

shown to reduce muscle stiffness, improve nerve conduction velocity, alter the force–velocity relationship, enhance lactate energy availability [8-10], and even boost muscular power performance [11].

Essentially, warming up is a preparatory phase conducted before training or competition; therefore, it must be performed effectively. According to Bompa [12], a well-structured warm-up can increase muscle elasticity, improve cardiac efficiency, and optimize performance during both learning sessions and matches. Moreover, warm-up sessions can serve as a medium for teaching fundamental football skills. As highlighted by Brown & Ferrigno [13], dynamic warm-ups that are specifically designed can integrate basic football techniques such as dribbling, passing, and shooting—making the process more meaningful and beneficial for learning. Dynamic warm-ups have become increasingly popular as they have been shown to improve physical readiness, enhance athletic performance, and reduce the risk of injury [14]. Moreover, combining dynamic and static warm-ups appropriately is important, as each type influences motor performance and skill learning differently [15]. However, in many schools and football clubs, warm-up sessions are often poorly planned, leading to a lack of understanding among students about their purpose and effectiveness in the learning process. Williams et al. [16] highlight the importance of providing players with varied and random training, such as small-sided games, to improve learning outcomes, which also requires effective instruction from coaches or teachers. Similarly, Ford et al. [17] suggest reorganizing training activities, including warm-ups, to make them more meaningful and supportive of football skill development. However, in practice, many educational institutions or clubs often conduct warm-ups that are poorly planned, resulting in a lack of understanding among students of their benefits and their potential to enhance football learning outcomes. Hence, developing an innovative and structured warming-up model has become essential to improve the quality of football education.

On the other hand, the current development of sports curricula and teaching approaches still tends to emphasize conventional and monotonous warm-ups, such as jogging around the field, static stretching, or repetitive drills unrelated to the core learning material. Therefore, it is important to develop a warm-up model that is based on learning materials. The incorporation of games within warm-up sessions has been proven to increase students' interest and engagement in learning activities [18-20]. The current curriculum trends in sports education emphasize the integration of physical activities with instructional content. Research evidence suggests that physical activities integrated with life skills programs are more effective in improving competencies compared to activities without such integration [21]. Furthermore, combining games with learning has been shown to play a significant role in enhancing technical skills within real-game contexts [22].

Based on these findings, every warm-up session

conducted before training or matches should be designed to directly contribute to technical skill development, thereby improving overall performance.

2. Materials and Methods

2.1. Design of Research

This study employs a Research and Development (R&D) design with the aim of developing a warming-up model based on the instructional content of football courses that aligns with students' needs. The development model used refers to the Borg and Gall approach, which has been modified into five stages: (1) information gathering (literature review and needs analysis); (2) design of the developed product; (3) expert validation and model revision; (4) small-scale field trials and model revision; and (5) large-scale field trials and final model revision. The flowchart of the learning-based warming-up model development is presented in Figure 1.

2.2. Research Subject

The research subjects were selected based on inclusion and exclusion criteria, using a purposive random sampling technique.

2.2.1. Inclusion Criteria

- a. Students who are willing to participate in all research sessions and provide written informed consent.
- b. Students enrolled in the Football course during the 2024/2025 academic year.
- c. Students in good physical condition without injuries that could hinder participation in physical activities.
- d. Students with a minimum attendance rate of 90% during the training sessions throughout the research period.
- e. Students who follow the training program designed based on the learning-based warming-up model.

2.2.2. Exclusion Criteria

- a. Students with medical conditions or injuries that could worsen with participation in intensive physical activity.
- b. Students currently undergoing treatment or recovery from significant injuries.
- c. Students who are unwilling to follow the research procedures or do not provide written consent.
- d. Students who fail to comply with the scheduled training and research timelines.
- e. Students with other commitments that interfere with consistent attendance and participation in the study.

A total of 30 students were selected for the small-scale trial group, and 100 students for the large-scale trial group.

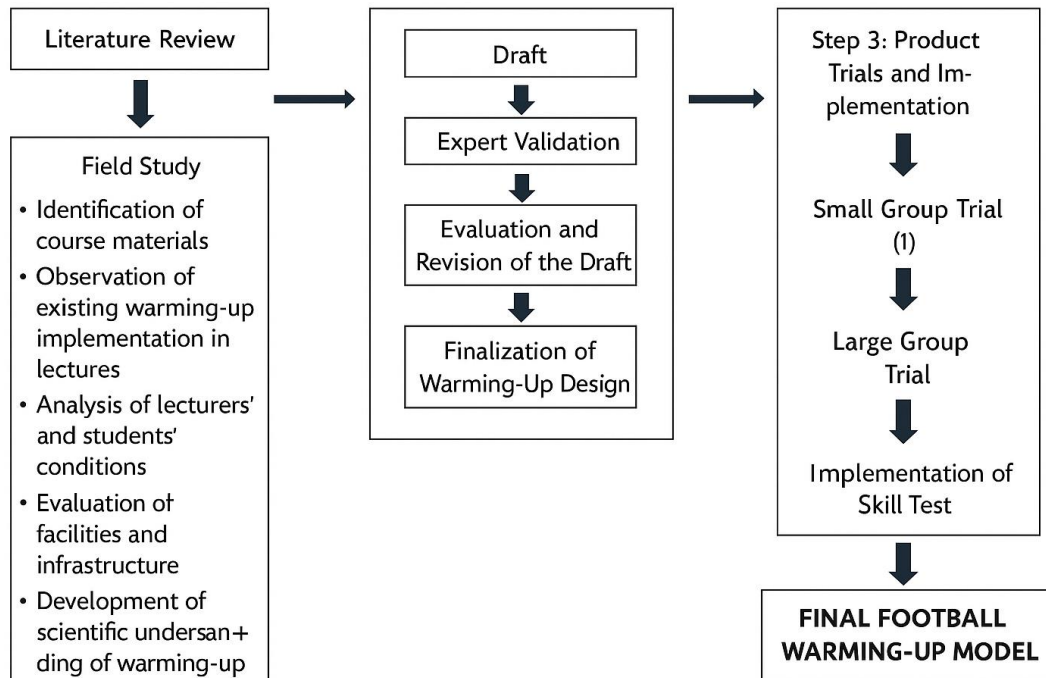


Figure 1. Development Procedure of the Football Warming-Up Model. The flowchart shows the systematic process of model development, beginning with literature and field studies, continuing through design and expert validation, and followed by small and large group trials before the final implementation

2.3. Research Instrument

This study employed the basic football skills test developed by Nusri et al. [23] as the primary research instrument. The findings indicated that the validity and reliability levels of the test were $r > 0.720$ and $r > 0.900$, respectively, suggesting that the developed test demonstrated strong psychometric properties and is suitable for implementation [24].

3. Results

3.1. Needs Analysis of Warming-Up among Academics and Students

The data presented in Table 1 indicate that students continue to face several challenges in carrying out warming-up activities, such as muscle stiffness, limited movement variation, and a lack of alignment with the learning material. Respondents also expressed the need for a warming-up model that is more relevant to football learning, more effective, and more efficient. Furthermore, 98.9% of respondents emphasized the necessity of developing warming-up methods that are more varied and integrated with the core material. These findings serve as an important basis for formulating a learning-based warming-up model that is more appropriate and capable of supporting the learning process more optimally.

3.2. Identification of Course Learning Outcomes (CPMK)

Based on the Football Course Learning Outcomes (CPMK) across three study programs—Sports Science, Physical Education, Health and Recreation, and Sports Coaching Education—it can be concluded that there are six types of skills that must be mastered by the end of the course, as shown in Table 2. The model was developed by referring to the football course learning outcomes, which state that students should be able to master basic technical, tactical, and physical skills in football. This learning-based warming-up model is designed to enhance the fundamental techniques required in playing football.

3.3. Development of a Learning-Based Football Warming-Up Model

The following is the design of the developed warming-up model.

3.3.1. Ball Feeling

1. Toe taps in place: Alternately tap the ball with the left and right foot while staying in place.
2. Rocking sole: Roll the ball inward and outward using the sole of one foot. After 1 minute, switch to the other foot.
3. Sole rolls: Roll the ball from left to right using the soles of the feet, alternating between the left and right foot.

4. Sole taps forward–backward: Alternately tap the ball with the left and right foot while moving forward for 10 meters, then backward.
5. Sole drags: Roll the ball with the soles of the feet from left to right for a distance of 10 meters.
6. Drags stop: Roll the ball with one foot’s sole and stop it with the other foot, alternating between left and right.
7. Croquetas (Iniestas): Juggle the ball using the inside of the feet under the groin area.
8. Pull and push: Pull and push the ball with the same foot, alternating between left and right.
9. Inside pull push: Pull the ball with the sole, then push it with the inside of the foot.
10. Juggling: Juggle the ball using the feet, thighs, and head.

Table 1. Needs Analysis of Warming-Up

Part 1: Understanding and Need for Warming-Up				
No	Question	Category	n	%
1	Do you understand the importance of warming up before playing football?	Strongly understand	43	46.2%
		Understand	45	48.4%
		Slightly understand	5	5.4%
		Do not understand	0	0.0%
2	How often do you perform warming up before training or a match?	Always	53	57.0%
		Often	29	31.2%
		Occasionally	10	10.8%
		Rarely	1	1.1%
3	Do you think the current warming-up methods are effective?	Very effective	28	30.1%
		Fairly effective	59	63.4%
		Less effective	4	4.3%
		Ineffective	2	2.2%
4	In your opinion, what aspects are still lacking in the current warming-up practice?	Variety of movements	50	53.8%
		Duration of warm-up	35	37.6%
		Relevance to football learning material	18	19.4%
		Student motivation during warm-up	32	34.4%
Part 2: Need for Developing a Warming-Up Model				
5	Do you think it is necessary to develop a warming-up model based on football learning material?	Very necessary	52	55.9%
		Necessary	40	43.0%
		Less necessary	1	1.1%
		Not necessary	0	0.0%
6	In your opinion, what components should be included in a learning-based football warming-up model?	Warm-up movements specific to football techniques	60	64.5%
		Exercises linked to game tactics	19	20.4%
		Short theoretical material before warming up	4	4.3%
		Game-based approach in warming up	10	10.8%
7	How significant is the impact of a good warming-up on football performance?	Very significant	70	75.3%
		Fairly significant	22	23.7%
		Slightly significant	1	1.1%
		No impact	0	0.0%
8	Do you experience any difficulties when performing warming up before playing football?	Yes, often experience difficulties	9	9.7%
		Occasionally experience difficulties	40	40.3%
		Rarely experience difficulties	22	23.7%
		Do not experience difficulties	22	23.7%

Table 2. Learning Outcomes of the Football Course

No	Type of Skill
1	Short passing
2	Long passing
3	Receiving
4	Dribbling
5	Shooting
6	Heading

3.3.2. Passing

1. Shadow short passing in place: Perform short passing movements alternately with the left and right foot while stationary.
2. Shadow short passing sideways: Perform short passing movements while moving sideways to the left and right alternately.
3. Shadow short passing forward–backward: Perform short passing movements while shifting forward and backward alternately.
4. Shadow passing to front: Perform short passing movements while moving forward over a set distance alternately.
5. Paired short passing (5 m): Perform inside-foot passes with a partner at a distance of 5 meters, alternating left and right feet.
6. Paired short passing (10 m): Perform inside-foot passes with a partner at a distance of 10 meters, alternating left and right feet.
7. Paired short passing (15 m): Perform inside-foot passes with a partner at a distance of 15 meters, alternating left and right feet.
8. Paired random-movement passing: Perform inside-foot passes in pairs within a 20 m × 20 m area, alternating between left and right feet.

3.3.3. Dribbling

1. Straight dribbling: Dribble straight ahead for 10 meters.
2. In-out dribbling: Dribble alternately using the inside and outside of the foot for 10 meters.
3. Zigzag dribbling (slalom): Dribble in a zigzag route through cones.
4. Feinting dribbling (Ronaldo style): Dribble while performing a step-over move (Ronaldo style) and continue dribbling in another direction for 15 meters.
5. Race dribbling: Conduct a group dribbling competition.

3.3.4. Shooting

1. Static shooting: Kick a stationary ball toward the goal using the instep from 10 meters, alternating left and right feet.
2. Accuracy shooting: Kick a stationary ball toward the goal using the instep from 15 meters, alternating left and right feet.
3. Dynamic shooting: Kick a rolling ball toward the goal using the instep from 15 meters, alternating left and right feet.
4. Dribbling to shoot: Dribble the ball and then shoot using the instep from 15 meters, alternating left and right feet.
5. Receiving and control to shoot: Receive a pass from a teammate, control the ball, and shoot using the instep from 15 meters, alternating left and right feet.
6. First-time shooting: Shoot directly at the goal without controlling the ball first, using the instep from 15 meters, alternating left and right feet, after receiving a forward pass.
7. Game shooting: Small-sided game (2v2, 3v3, or 4v4 with neutral players) on a small field focused on shooting.

3.3.5. Heading

1. Heading without jump (pair 1): Perform heading in pairs from 2 meters apart; player A heads the ball thrown by player B.
2. Heading pair without jump (pair 2): Perform back-and-forth heading in pairs from 2 meters apart.
3. Heading pair without jump (pair 3): Perform back-and-forth heading in pairs from 4–5 meters apart.
4. Heading pair with jump (pair 4): Perform back-and-forth heading with jumps in pairs from 4–5 meters apart.
5. Self-heading: Perform individual heading exercises.

6. Heading game: Play 5v5 on a 30×40 m field. Players may throw the ball with both hands, but the receiver must head it to a teammate. The team's goal is to complete 5–6 consecutive headers without interruption from the opposing team.
7. Heading volley play: Play like volleyball (5v5). Each team is allowed a maximum of 3 headers before sending the ball across to the opposing side. All ball contacts must be made by heading.

3.4. Expert Validation of the Warming-Up Model

Expert validation was conducted by two football experts, with results calculated using the Scale-level Content Validity Index (S-CVI/Ave) based on the average method, as shown in the following table.

Table 3. Expert Validity Test

Evaluator	S-CVI
Expert 1	0.90
Expert 2	0.86

The S-CVI/Ave values from both expert validations indicate that the questionnaire possesses high content validity. The scores of 0.90 and 0.86 are above the generally accepted threshold (0.80 [25]), signifying that the questionnaire items are relevant and accurately represent the aspects intended to be measured, according to expert judgment in the field of football. This indicates that the questionnaire is substantively suitable for further use in the next stage.

3.5. Small-Scale Trial

The small-scale trial was conducted on 30 students from the Faculty of Sports Science (FIK), randomly selected from the entire population, using the test developed by Nusri et al. [24].

Table 4. Average Scores of Small-Scale Trial

No.	Variable	Average Scores	
		Small-Scale Group 1	Small-Scale Group 2
1	Short passing	74	79
2	Long passing	54	65
3	Receiving	70	75
4	Dribbling	57	64
5	Shooting	54	59
6	Heading	53	58
7	Bleep test	36	38

Based on the results of Small-Scale Trials 1 and 2, a comparison test was conducted between pre- and post-intervention scores. The following table presents the

results of the paired sample t-test between the values before and after the treatment.

Table 5. Comparison Test Between Small-Scale Groups

Variable	Mean ±SD	t (29)	p-value
Passing	-4.73 ±8.18	-3.17	0.004
Receiving	-5.33 ±10.47	-2.79	0.009
Dribbling	-6.80 ±13.35	-2.79	0.009
Long passing	-10.47 ±15.44	-3.71	0.001
Shooting	-7.50 ±12.00	-3.00	0.006
Heading	-5.90 ±11.00	-2.85	0.008
Bleep test	-2.23 ±3.00	-4.07	< 0.001

Overall, these results indicate that the intervention or treatment provided produced a significant change in all tested variables.

3.6. Large Scale Trial

The researcher conducted a large-scale trial involving 100 students from the Faculty of Sports Science (FIK), Universitas Negeri Medan, using the warming-up model developed in the previous stage.

Table 6. Average Scores of the Large-Scale Trial

No.	Variable	Average Scores
1	Short passing	82
2	Long passing	62
3	Receiving	76
4	Dribbling	69
5	Heading	66
6	Shooting	64
7	Bleep test	59

4. Discussion

The warming-up model developed in this study proved effective in improving students' abilities, as evidenced by the results after treatment. The model was designed based on the football course curriculum, making it relevant to the course learning outcomes, namely the mastery of basic football skills. Consequently, each warming-up activity serves not only physiological purposes—such as reducing muscle stiffness and increasing hamstring flexibility [26], enhancing nerve conduction rate, preventing musculoskeletal injuries [27], accelerating muscular conduction response [28], boosting anaerobic energy contribution (phosphagen and glycolytic) [29], and increasing baseline oxygen consumption—but also stimulates technical aspects of football performance.

In addition, warming up can have positive

psychological effects such as mental stability, readiness, and confidence before training or matches [30]. These psychological effects, in turn, enhance motivation, which significantly influences football skills [31].

Football is classified as an endurance sport, requiring optimal physical stamina. Therefore, an appropriate warming-up routine can improve athletes' endurance. Intermittent warming-up, for instance, has been shown to significantly extend the time to fatigue [32]. Moreover, modern structured warm-ups have proven to be more effective than conventional methods, particularly in enhancing speed, agility, and endurance [33]. In educational contexts—especially within faculties of sports science—warming-up models should align with the learning outcomes, focusing on the mastery of basic football skills. Hence, using the ball as the primary medium during warming-up is an appropriate and relevant approach.

Basic football skills are fundamental abilities every player must master. At the athlete level, game-based warming-up models can be used to prepare the body for main activities [34]. Meanwhile, at the student level, adaptation is required so that warming-up becomes an integrated part of the learning process, accelerating the understanding and mastery of basic football techniques. For example, target shooting exercises have been shown to significantly improve passing accuracy [35]. Warm-ups focusing on shooting make the exercises more purposeful, as students practice kicks alternately using the left and right insteps. Additionally, dynamic warm-up exercises have been proven to enhance slalom dribbling performance [36]. Integrating dynamic exercises with ball usage makes warming-up more effective in improving basic football techniques, especially dribbling.

Heading is also one of the essential basic skills. Consistent training can improve fine motor control, particularly by reducing tremor frequency during precision grip tasks [37]. Although heading is less frequent in modern football [38], proper practice still contributes to performance. Flexibility is also necessary to improve heading accuracy, maintain effective technique, and reduce injury risk [39]. Therefore, warming-up routines should align with the basic football skills targeted in learning outcomes.

Physiologically, warming up before matches or training has been shown to increase maximal oxygen consumption. Pre-exercise warming-up helps the body better cope with physical stress, improves thermoregulatory efficiency, and supports endurance performance [40]. However, research has shown that general warm-ups alone are insufficient to reduce injury risk or adequately prepare the body for physical stress [41]. Selecting the right warming-up method can significantly improve $VO_2\max$ [42] and help regulate lactic acid levels, allowing the body to perform better during submaximal activity [43]. Therefore, warming-up effectiveness should be contextualized—including in university-level instruction.

The model developed in this study is grounded in course learning outcomes—mastery of basic football techniques—making it directly applicable to football classes.

Consistent with this principle, the theory of Representative Learning Design [44] emphasizes that training and warm-up activities should maintain the informational characteristics of the actual competitive environment. In other words, the use of the ball becomes essential so that the activities performed accurately reflect the demands of real match situations. Beyond representativeness, warm-up routines should also facilitate both cognitive and motor readiness. Warm-ups that integrate dual-task elements and open-skill situations have been shown to enhance perceptual—motor readiness, focus, and players' reactive abilities during explosive actions [45]. In addition to improving performance, warm-ups incorporating short- to medium-duration cognitive tasks represent one of the most effective strategies for reducing the negative effects of mental fatigue caused by sleep deprivation, while simultaneously enhancing physical activity and cognitive function [46]. Furthermore, Grooms et al. [47] demonstrated that effective warm-up routines can reduce injury occurrence in football players when integrating key components of FIFA's 11+ programme. Based on these findings, the development of the warm-up model in this study aligns with the learning objectives of the course, aiming to improve students' fundamental football skills comprehensively—physically, motorically, and cognitively.

5. Conclusions

The warm-up model developed in this study has proven effective not only in physiological aspects—such as improving muscle flexibility, neuromuscular responsiveness, oxygen consumption, and injury prevention—but also in psychological dimensions, including enhanced mental readiness, emotional stability, and self-confidence prior to training or competition. Integrating a warm-up model based on the football course curriculum allows students to obtain dual benefits: optimal physical preparation and simultaneous stimulation of fundamental technical skills such as passing, dribbling, shooting, and heading.

The findings further demonstrate that employing a ball-based warm-up as the primary medium can significantly accelerate students' comprehension and mastery of basic football skills. Compared with conventional methods, this model is more effective in improving speed, agility, endurance, and learning motivation. Moreover, warm-up activities that are specifically tailored to particular techniques—such as shooting or dribbling—produce direct and measurable effects on students' performance during training sessions and gameplay.

Consequently, a learning-oriented warm-up model may serve as a practical and relevant alternative in university-level football instruction. These results are expected to contribute to the development of pedagogical strategies in sports education, particularly in promoting learning outcomes that integrate physiological, technical, and psychological components.

5.1. Limitations and Directions for Future Research

Despite these promising outcomes, the present study has several limitations. The sample consisted exclusively of university students from a single institution, which restricts the generalisability of the findings. Future research should examine the effectiveness of this warm-up model across broader populations, including different age groups, competitive levels, and female athletes. Longitudinal studies are also recommended to assess whether improvements in skill acquisition and injury prevention are retained over time.

5.2. Practical Implications

This warm-up model offers several practical implications for coaches, physical education teachers, and curriculum developers. The structured integration of technical elements into warm-up routines can be readily implemented in real training environments to enhance both physical readiness and skill efficiency. Providing clear guidelines on session design, progression, and adaptation may further support practitioners in adopting this approach to optimise training quality and athlete development.

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