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Experimental Study of the Effect of Problem-Based Learning Model in Basketball Learning on Students' Critical Thinking Skills

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ABSTRACT

This study aims to analyze the effect of the Problem-Based Learning (PBL) model on students' critical thinking skills in basketball lessons at SMA Negeri 5 Makassar. The study used a quasi-experimental design with a pretest-posttest control group pattern involving 40 students, consisting of 20 in the experimental group and 20 in the control group. The instrument used was a critical thinking ability test based on the context of a basketball game. The results showed that the experimental group, who received PBL learning, experienced a significant increase in their critical thinking scores, from an average pretest score of 56.40 to 82.75 on the posttest, a difference of 26.35 points. Meanwhile, the control group, which received conventional learning, only experienced an increase from 55.85 to 68.10, a difference of 12.25 points. Paired sample t-test analysis showed significant improvement in both groups, but the experimental group's improvement was significantly greater ($t = 12.85$; $p = 0.000$) than the control group's ($t = 6.14$; $p = 0.000$). The independent sample t-test results showed a significant difference in critical thinking skills improvement between the experimental and control groups ($t = 7.21$; $p = 0.000$). The effect size value of 2.15 indicates that the influence of the PBL model is categorized as very large. Thus, this study confirms that the PBL model is an effective learning approach in improving students' critical thinking skills, especially in the context of sports learning based on problem-solving and tactical analysis of games.

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INTRODUCTION

Physical education learning in the 21st century is no longer understood solely as a physical activity focused on improving motor skills, but has evolved into a comprehensive learning platform that integrates cognitive, affective, and social aspects in a balanced manner. The current educational paradigm shift is geared toward creating learning experiences that foster higher-order thinking skills (HOTS), one of which is critical thinking. In the context of the Merdeka Curriculum (independence curriculum) and the 2013 curriculum, which is still widely implemented, critical thinking skills are an essential competency that must be developed across various subjects, including Physical Education, Sports, and Health (PJOK) (Pratama & Firmansyah, 2022; Hidayat & Rachman, 2021).

Critical thinking is the ability to analyze, evaluate, and interpret information to produce rational decisions and effective solutions to real-world problems faced by students (Facione, 2020). In the context of sports learning, critical thinking is crucial because students are faced with complex game situations, requiring rapid analysis, decision-making, and the ability to choose appropriate playing strategies. Research shows that critical thinking skills can develop more optimally if students are involved in problem-based learning activities and direct experiences (Sagala, 2020; Indrawan et al., 2021).

In basketball, critical thinking skills play a strategic role because the game requires players to understand match situations, read the movements of opponents and teammates, and choose effective offensive or defensive techniques. Students must be able to identify in-game problems, such as passing errors, inappropriate positioning, or failure to defend. Therefore, a learning process that provides space for students to solve problems independently will be more effective in fostering critical thinking skills (Sutisna & Kurniawan, 2020).

The Problem-Based Learning (PBL) model is an innovative learning approach that places real-world problems as the foundation to encourage students to learn independently, collaboratively, and reflectively. PBL was originally developed in medical education but has now proven effective in various subjects, including physical education (Barrows, 2018; Yulianti et al., 2020). In the context of basketball learning, PBL can be integrated through game scenarios containing tactical, technical, and strategic problems that students must solve through discussion, exploration, and decision-making.

Several studies have shown that the PBL model can significantly improve students' learning activities, problem-solving abilities, and critical thinking skills (Hendri & Mahfud, 2020; Saputra & Nurhayati, 2021). In Physical Education (PJOK) learning, PBL has been shown to improve students' understanding of game concepts and their ability to analyze match situations (Hidayat et al., 2022). The application of PBL in basketball has resulted in improved student playing ability, tactical discipline, and social skills relevant to collaborative learning contexts (Rahmawati, 2021).

However, the implementation of PBL in basketball instruction at the high school level, particularly in Makassar, is still rare. The majority of PJOK teachers still use an expository approach and drill techniques that focus on mastering fundamental movement skills without providing room for exploratory problem-solving. However, through the integration of PBL, students can gain a more meaningful understanding of the game because they are directly involved in the process of analyzing and solving game problems.

SMA Negeri 5 Makassar, one of the public schools in Makassar, faces challenges in its physical education (PJOK) learning, which is still dominated by traditional methods. Initial observations by researchers indicate that students are less engaged in tactical discussions, are not accustomed to analyzing game situations, and are less able to make appropriate decisions during basketball games. This is reflected in several indicators, such as low passing accuracy, misreading opponent movements, and ineffective defensive and offensive strategies.

Furthermore, interviews with PJOK teachers revealed that students' critical thinking skills are relatively low because learning is not based on situational analysis.

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Teachers also acknowledged that innovative learning models such as PBL have not been optimally implemented due to limited references and experience. This situation is a critical issue that needs to be addressed so that basketball learning can significantly develop students' cognitive aspects, not just psychomotor aspects.

Research on the application of PBL in PJOK learning has been conducted in various contexts, but most have focused on improving learning motivation, general cognitive learning outcomes, or technical game skills. Very limited research specifically examining the effect of PBL on critical thinking skills in the context of basketball at the high school level.

Several previous studies have shown positive results, but most were conducted at the junior high or university level (Lestari & Wijaya, 2020; Mahendra et al., 2021). Furthermore, research in Makassar focusing on the context of sports learning using a PBL approach, particularly in basketball, is still limited. Research using a purely experimental method with a pretest–posttest control group design to test the effectiveness of PBL on high school students' critical thinking skills is also scarce in the national literature. Thus, there is a research gap in three main aspects: (1) local context (Makassar), (2) focus variable (critical thinking skills), and (3) specific sport context (high school basketball).

The novelty of this research lies in its systematic and measurable integration of the Problem-Based Learning model, based on tactical basketball problem-solving, into Physical Education (PJOK) learning. This research offers a novel contribution in the form of an empirical analysis that experimentally tests the effectiveness of PBL on improving critical thinking skills, measured not only cognitively but also in relation to the situational context of basketball.

This research also provides novelty in the learning design aspect, namely, combining game-based problem scenarios with cognitive reflection as a strategy to enhance critical thinking. Furthermore, this research provides new empirical evidence in a public school environment in Makassar that has not previously been widely explored by other researchers.

Based on this background, this study was conducted to address the problem of students' low critical thinking skills in basketball learning and to test the effectiveness of the Problem-Based Learning model as an innovative approach to PJOK learning. The experimental approach was chosen to provide strong empirical evidence regarding the effect of PBL on the variables studied. This research is expected to provide scientific contributions as well as practical recommendations for PJOK teachers at SMA Negeri 5 Makassar and other schools to implement learning models that better stimulate students' critical thinking skills.

METHODS

Research Type and Design

This study employed a quasi-experimental design with a pretest–posttest control group design, commonly used in educational research to test the effectiveness of a learning model on student learning outcomes or cognitive abilities (Creswell & Guetterman, 2020). This design involved two groups: an experimental group receiving treatment using the Problem-Based Learning (PBL) model, and a control group receiving conventional learning. Both groups were

given a pretest to measure critical thinking skills before the treatment, and a posttest to determine the effect of the learning model after the treatment.

The pretest–posttest control group design was chosen because it allows researchers to control baseline variables, minimize bias, and ensure that any differences in results are truly caused by the learning treatment (Fraenkel et al., 2018). In the context of physical education (PJOK) learning, this design is often used to assess the effectiveness of innovative learning models such as PBL on students' cognitive and thinking skills (Mahendra et al., 2021; Hidayat & Rachman, 2021).

The implementation of PBL in this study was carried out through several stages adapted from modern PBL model guidelines: identifying game problems, group discussions, exploring game strategies, implementing solutions through basketball, and critical reflection. These stages allow students to actively engage in problem-solving, thus directly impacting their critical thinking skills (Saputra & Nurhayati, 2021).

Research Variables

This study has two types of variables: (1) Independent variable: The Problem-Based Learning (PBL) model applied to the experimental group. PBL is a problem-based learning model that requires students to think critically, collaborate, and solve problems relevant to the game context (Barrows, 2018; Yulianti et al., 2020). And (2) Dependent variable: Students' critical thinking skills, as measured using a critical thinking test instrument specifically for the basketball learning context in Physical Education and Health.

The control variables in this study were students' initial abilities, learning materials, learning duration, and the teacher. Controlling these variables is important to ensure that the research results truly reflect the effect of the treatment (PBL) on critical thinking skills (Pratama & Firmansyah, 2022).

Population and Sample

The population in this study was all tenth-grade students at SMA Negeri 5 Makassar who were participating in Physical Education (PJOK) lessons during the current semester. Based on school data, there were four tenth-grade study groups actively participating in basketball lessons. However, for this experimental research, which required control over external variables, the sample was selected using purposive sampling based on equivalence of academic ability and willingness to participate in the entire study. The total sample size was 40 students, divided into two groups: 20 students as the experimental group, and 20 students as the control group.

The purposive sampling technique was used because the researcher considered certain characteristics, such as age homogeneity, initial ability, and student engagement in PJOK lessons. This technique is widely used in educational and sports research to minimize sample variability that could influence research results (Sugiyono, 2021; Lestari & Wijaya, 2020).

Test Instrument

The instrument used in this study was a critical thinking skills test based on Facione's (2020) Critical Thinking Skills theoretical framework, which includes five main indicators: (1) Interpretation, (2) Analysis, (3) Evaluation, (4) Inference, and (5) Explanation.

The test instrument consisted of analytical essay questions contextualized within a basketball game, such as game scenario analysis, defensive strategy selection, passing error analysis, and tactical decisions during fast breaks. The use of contextual questions is recommended by various studies because it stimulates authentic problem-solving (Indrawan et al., 2021; Sutisna & Kurniawan, 2020).

The instrument's content validity was tested by three experts in the fields of physical education and cognitive measurement. Reliability was calculated using Cronbach's Alpha and was declared highly reliable, with a value >0.80, according to educational measurement standards (Fraenkel et al., 2018).

Data Collection Techniques

Data collection was conducted through three main stages: (1) Critical Thinking Skills Pretest; This was conducted at the beginning of the study to measure students' critical thinking skills before receiving the treatment. The pretest was a written test and lasted 60 minutes. (2) Problem-Based Learning Model Treatment; The experimental group received PBL learning for six sessions, each lasting two 45 minutes, following the PBL stages: problem orientation, problem analysis, information gathering, solution discussion, strategy implementation in the game, and reflection (Yulianti et al., 2020). The control group used traditional learning methods such as lectures, demonstrations, and basic basketball technique practice, and (3) Critical Thinking Skills Posttest; This was conducted after all treatments were completed to measure improvements in students' critical thinking skills.

Research data was collected directly by the researcher with the assistance of the Physical Education and Health (PJOK) teacher to ensure compliance with the implementation procedures.

Data Analysis Techniques

Data analysis was conducted using a quantitative statistical approach. The analysis stages are shown in the following table:

Table 1.
Tahapan Analisis Data Statistik Kuantitatif

Analysis Stages	Test Type	Objective	Theoretical Basis / References	Decision Criteria
Statistical Prerequisite Test				
Normality Test	Kolmogorov–Smirnov	Ensure that the pretest and posttest data in the experimental and control groups are normally distributed.	Ghozali (2020)	$p > 0,05 \rightarrow$ normal data
Homogeneity of Variance Test	Levene's Test	To find out whether the variance of the two groups is homogeneous	Ghozali (2020)	$p > 0,05 \rightarrow$ homogeneous variance
Hypothesis Testing				
Paired Sample t-Test	Paired t-test	Looking at the differences in pretest–posttest scores in the experimental and control groups	Mahendra et al. (2021)	$p < 0,05 \rightarrow$ there is a significant influence

Analysis Stages	Test Type	Objective	Theoretical Basis / References	Decision Criteria
Independent Sample t-Test	Uji t independen	Menguji perbedaan peningkatan kemampuan berpikir kritis antara group eksperimen dan kontrol	Creswell (2020)	within the group $p < 0,05 \rightarrow$ there are significant differences between groups
Effect Size	Cohen's d	Knowing the extent of the influence of the PBL model on critical thinking skills	Cohen (d-guideline)	d = 0.2 (small); 0.5 (medium); >0.8 (large)

Table 2.
Interpretasi Effect Size (Cohen's d)

Range of Values d	Impact Category	Meaning
0.20	Small	Low influence and less significant in a practical context
0.50	Medium	Moderate influence and quite significant
0.80 or more	Large	Strong and significant influence
> 2.00	**Very Large (Strong Impact)**	**The intervention has a very strong effect on changes in the variable**

Table 3.
Data Analysis Flow

Step	Description of Analysis Activities	Output
1	Calculating descriptive statistics (mean, SD) pretest–posttest	Initial data description
2	Kolmogorov–Smirnov normality test	Normal/abnormal data
3	Test of homogeneity of variance	Homogeneous/inhomogeneous variance
4	Paired Sample t-Test	Effect of treatment within groups
5	Independent Sample t-Test	Difference in improvement between groups
6	Effect Size (Cohen's d)	Magnitude of the PBL model's influence

All analyses were conducted using the latest version of SPSS software to ensure the accuracy of the results and the appropriateness of the statistical tests (Ghozali, 2020).

RESULTS AND DISCUSSION

Result

This research results section presents statistical findings based on an analysis of two sample groups: an experimental group (using the Problem-Based Learning (PBL) model) and a control group (using conventional learning). The total sample size was 40 students, with 20 students per group.

Statistical Description of Critical Thinking Skills

Table 4.
Descriptive Statistics of Critical Thinking Skills

Group	N	Pretest (Mean ± SD)	Posttest (Mean ± SD)	Difference (Δ)
Experiment (PBL)	20	56.40 ± 7.15	82.75 ± 6.20	**+26.35**
Control (Conventional)	20	55.85 ± 6.90	68.10 ± 7.40	**+12.25**

The table shows that both groups had relatively similar pretest abilities, but the experimental group improved significantly compared to the control group. This demonstrates the strong potential of the PBL model in improving critical thinking skills.

Statistical Prerequisite Test

Table 5.
Normality Test (Kolmogorov-Smirnov)

Group	Pretest (p-value)	Posttest (p-value)	Information
Experiment (PBL)	0.200	0.176	Normal data
Control (Conventional)	0.152	0.221	Normal data

All p values > 0.05 indicate that the data are normally distributed.

Table 6.
Homogeneity of Variance Test (Levene Test)

Variable	p-value	Information
Pretest	0.612	Homogeneous
Posttest	0.438	Homogeneous

Because the p value > 0.05, both groups have homogeneous variance so that parametric tests can be used.

Paired Sample t-Test

Table 7.
Paired t-Test Pretest–Posttest

Group	t-value	p-value	Information
Experiment (PBL)	12.85	**0.000**	Significant
Control (Conventional)	6.14	**0.000**	Significant

Both groups experienced significant improvement. However, the experimental group had a significantly higher t-score, indicating greater improvement.

Independent Samples t-Test

Table 8.
Independent t-Test Improvement (Δ)

Variable	Mean Δ	t-value	p-value	Information
Experiment (PBL) vs Control (Conventional)	26.35 vs. 12.25	7.21	**0.000**	Signifikan

There was a significant difference between the experimental and control groups in improving critical thinking skills. The PBL model had a much greater impact than conventional learning.

Effect Size (Cohen's d)

Calculation:
d = (Mean posttest Experiment – Mean posttest Control) / SD Pooled
d ≈ (82.75 – 68.10) / 6.82
d ≈ 2.15 (very large effect size)

Table 9.
Interpretation of Effect Size

Value d	Category
0.2	Small
0.5	Medium
0.8	Large
> 2.0	**Very Large**

The effect size of 2.15 shows that the PBL model has a very strong impact on students' critical thinking abilities.

The results of the study showed that the implementation of the Problem-Based Learning model significantly improved students' critical thinking skills in basketball learning. Descriptive analysis revealed that the experimental group experienced an average increase of 26.35 points, significantly higher than the control group, which only increased by 12.25 points.

Normality and homogeneity tests indicated that the data met statistical assumptions. A paired-sample t-test confirmed that both groups experienced significant improvement, but the improvement in the experimental group was stronger with a higher t-value ($t = 12.85$; $p < 0.001$).

Furthermore, the results of the independent-sample t-test showed a highly significant difference in improvement between the two groups ($t = 7.21$; $p < 0.001$), indicating that the implementation of PBL had a significantly greater positive impact than conventional learning.

The effect size calculation yielded a value of 2.15, indicating a very strong effect. This demonstrates that PBL not only has a statistically significant impact but also has a significant practical impact on improving the critical thinking skills of students at SMA Negeri 5 Makassar.

The results of this study confirm that a problem-solving-based learning approach is able to stimulate students' cognitive activities more optimally, especially in the context of learning basketball games, which require analysis of game situations, quick decision-making, and appropriate tactical evaluation.

Discussion

The research results show that the implementation of the Problem-Based Learning (PBL) model significantly improved students' critical thinking skills in basketball lessons at SMA Negeri 5 Makassar. This improvement is evident in the comparison of pretest and posttest scores between the experimental and control groups. The experimental group experienced an increase of 26.35 points, while the control group only increased by 12.25 points. This difference indicates that PBL is able to stimulate students' cognitive activity more deeply than conventional learning methods. This section discusses the results by linking the research findings to educational theory, previous research, and the context of physical education (PJOK) learning.

Interpretation of Key Findings

The improvement in students' critical thinking skills through PBL learning aligns closely with the model's characteristics, which emphasize analysis, evaluation, and problem-solving based on real-life situations. PBL requires students to engage in problem identification, game situation analysis, group discussions, and formulating strategic solutions within a basketball game. This process encourages the activation of higher-order cognitive functions, as emphasized by Barrows (2018), who stated that PBL

designs learning through complex problem situations that stimulate critical and reflective thinking.

The results of this study align with those of Hidayat and Rachman (2021), who found that problem-based learning can improve students' critical thinking skills in various subjects, including Physical Education and Health. Similarly, research by Mahendra et al. (2021) found that PBL improves students' ability to identify tactical problems in games and develop solutions based on situational analysis. These research findings strengthen the argument that PBL is a highly effective model for improving higher-order thinking skills.

In the context of basketball learning, critical thinking skills are essential because students must be able to read their opponents' movements, determine offensive or defensive strategies, and evaluate errors in play. Sutisna and Kurniawan (2020) emphasized that basketball requires quick decisions based on visual and spatial analysis. When students are allowed to solve game problems using PBL, they directly develop critical thinking skills through authentic game situations.

Relationship of Research Findings to Critical Thinking Theory

Theoretically, critical thinking skills encompass five main indicators: interpretation, analysis, evaluation, inference, and explanation (Facione, 2020). These five indicators have been shown to develop in the implementation of PBL. In the problem identification stage, students practice interpretation and analysis. In the game strategy exploration stage, students practice evaluation and inference skills, while in the presentation and reflection sessions, students develop explanation skills.

This research shows that student engagement throughout the PBL cycle facilitates the comprehensive development of critical thinking skills. This aligns with the research findings of Saputra and Nurhayati (2021), which showed that PBL provides a learning environment that encourages students to ask questions, discuss, formulate solutions, and evaluate their own thinking.

Furthermore, group discussion activities in PBL contribute to the development of critical thinking skills through social reasoning. As explained by Indrawan et al. (2021), social interactions in group discussions encourage students to defend their opinions, analyze their peers' arguments, and validate decisions based on data or game facts. This process strengthens students' critical thinking skills.

Comparison with Previous Research

The findings of this study are consistent with several previous studies showing that PBL effectively improves cognitive and critical thinking skills in sports learning. Yulianti et al. (2020) found that PBL can improve cognitive learning outcomes in invasive game learning. Research by Hendri and Mahfud (2020) also supports the belief that PBL is more effective than conventional methods because it provides learning tasks that require problem-solving.

Internationally, several studies in reputable Scopus journals have shown that PBL supports higher-order thinking skills and decision-making in sports learning (Thomas & Brown, 2019; Köksal & Yilmaz, 2018). For example, research by Thomas and Brown (2019)

found that PBL helps students understand game dynamics through situational analysis, thereby improving decision-making skills.

Therefore, the results of this study not only support previous research but also provide a new context because it was conducted in a high school basketball learning environment in Makassar, a context that has rarely been studied.

Factors Supporting the Effectiveness of PBL in Basketball Learning

Several factors contribute to the effectiveness of PBL in improving students' critical thinking skills, namely:

1. Active Student Involvement
   PBL requires students to be active in every stage of learning. This active involvement aligns with the student-centred learning paradigm, which positions students as the subjects of learning (Pratama & Firmansyah, 2022). In basketball learning, activities such as analyzing passing errors, formulating fast-break strategies, or determining zone defense patterns provide meaningful learning experiences that enable students to develop critical thinking.
2. Authentic Problems in the Game
   The problems presented in PBL are authentic and relevant to the game of basketball, thus boosting student motivation and improving the quality of their problem-solving (Yulianti et al., 2020). When problems are perceived as real, students are encouraged to find appropriate solutions based on the context of the game.
3. Collaboration and Group Interaction
   PBL emphasizes collaboration through group discussions. This interaction enhances critical thinking skills through argumentation, where students challenge each other's ideas and validate their decisions based on game data (Indrawan et al., 2021).
4. Reflection as a closing step in learning
   The reflection phase in PBL provides an opportunity for students to evaluate the results of their decisions and identify areas for improvement. This strengthens conceptual understanding and fosters ongoing critical thinking (Hidayat & Rachman, 2021).

Analysis of Differences Between Groups

The results of the independent t-test showed that the difference in improvement between the experimental group (26.35 points) and the control group (12.25 points) was highly significant. This indicates that the improvement in critical thinking skills was not solely due to the basketball learning itself, but was strongly influenced by the type of learning model used.

The conventional learning provided to the control group emphasized technique demonstrations and repetitive practice (drills). While this learning improved students' motor skills, this approach provided little opportunity for students to analyze game situations or develop critical thinking skills. This aligns with the findings of Rahmawati (2021), who stated that teaching basic techniques through drills was not effective enough to develop higher-order thinking skills.

In contrast, PBL provided a rich learning experience focused on problem-solving, thus encouraging the optimal development of students' cognitive structures. The large

difference in scores was also confirmed by the effect size calculation, which yielded a d value of 2.15, categorized as a very strong effect. This indicates that PBL is not only statistically effective but also very powerful in practice.

Research Implications

The findings of this study have several important implications for education, particularly for physical education and basketball.

1. PBL as a Relevant Learning Model for Physical Education
   PBL can be an alternative learning model for developing students' cognitive and psychomotor aspects. Physical education should not only focus on physical fitness but should also stimulate critical thinking, creativity, and problem-solving skills.
2. Teachers Need to Integrate Authentic Problems into Games
   Teachers should design game scenarios that require students to analyze, evaluate, and generate solutions. This helps make learning more meaningful and effective.
3. PBL Improves Student Decision-Making
   PBL strengthens students' ability to read the game, which is a crucial skill in basketball. Teachers can use it to build their tactical competencies.
4. Training Needs for Physical Education Teachers
   For PBL to be implemented optimally, teachers need training on how to design problems, facilitate discussions, and conduct cognitive-based evaluations.

Research Limitations and Directions for Further Research

This study has several limitations that require further research. First, it was conducted in one school with a limited sample size (40 students). Second, the study focused on only one sport, namely basketball. Third, the treatment duration was relatively short, so improvements in critical thinking skills might be more optimal if the learning duration were extended.

Further research could expand the context to other schools, other sports, or use a longer-term experimental design. Furthermore, the use of more standardized critical thinking instruments could provide a more comprehensive picture.

CONCLUSION

Based on the research results, it can be concluded that the implementation of the Problem-Based Learning (PBL) model significantly improved students' critical thinking skills in basketball lessons at SMA Negeri 5 Makassar. Data show that the experimental group, which received PBL instruction, experienced an average score increase of 26.35 points, from a pretest score of 56.40 to a posttest score of 82.75. Meanwhile, the control group, which received conventional instruction, only experienced a score increase of 12.25 points, from a pretest score of 55.85 to a posttest score of 68.10.

The paired sample t-test analysis showed that both groups experienced significant improvement, but the improvement in the experimental group was significantly greater ($t = 12.85$; $p = 0.000$) than in the control group ($t = 6.14$; $p = 0.000$). Furthermore, the independent sample t-test results showed a highly significant difference in improvement between the

two groups (t = 7.21; p = 0.000), confirming that the PBL model directly contributed to improving students' critical thinking skills. The effect size of 2.15 indicates that the PBL model's effect is in the very large category, meaning that this model is not only statistically effective but also has a strong practical impact in the context of sports learning.

Thus, it can be concluded that the PBL model is a highly effective learning approach for improving students' critical thinking skills, particularly in learning oriented toward problem-solving and analyzing game situations such as basketball. The results of this study can serve as a basis for physical education teachers to integrate PBL as an innovative learning strategy in schools.

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