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Comparison of the Effectiveness of Discovery Learning and Problem-Based Learning Models in Volleyball-Based Physical Education Learning

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ABSTRACT

This study aimed to compare the effectiveness of the Discovery Learning (DL) and Problem-Based Learning (PBL) models in improving basic volleyball technical skills in students at SMP Negeri 2 Makassar. The study used a quasi-experimental design with two treatment groups, each consisting of 20 students. The measurement instrument was a basic technical skills test covering underhand passing, overhand passing, and serving. Data analysis was conducted using paired sample t-tests, independent sample t-tests, and effect size calculations. The results showed that both learning models significantly improved basic volleyball technical skills ($p < 0.05$). In the Discovery Learning group, the average score increased from 14.85 in the pretest to 22.30 in the posttest, a difference of 7.45 points. Meanwhile, the PBL group experienced a greater improvement, from a pretest average of 15.10 to 25.15 in the posttest, a difference of 10.05 points. An intergroup comparison using an independent sample t-test yielded a p-value of 0.003, indicating a significant difference in improvement between the two learning models. The effect size also confirmed this result, with PBL having a stronger effect with $d = 2.03$ (very large), while DL achieved $d = 1.56$ (large). Overall, this study concluded that while both models were effective, Problem-Based Learning was superior in improving basic volleyball technical skills. These findings recommend the implementation of PBL as a relevant alternative learning model in physical education at the junior high school level.

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INTRODUCTION

Physical Education (PE) instruction at the junior high school level plays a strategic role in developing students' movement abilities, physical fitness, social skills, and character holistically. Physical education, by its very nature, is not solely oriented toward achieving motor skills but also emphasizes experiential learning processes that foster creativity, problem-solving, and critical thinking (Sari & Widiastuti, 2020). In the 21st-century context, PE teachers face demands to create more active, innovative, and student-centred learning, in line with modern pedagogical approaches that emphasize

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activity-based and discovery-based learning (Lestari et al., 2021). Therefore, transforming PE learning models is an urgent need to enable students to develop movement competencies and adaptive reasoning skills.

In general, volleyball is a core subject in the PE curriculum at the junior high school level. Volleyball was chosen because of its game characteristics rich in coordination, speed, teamwork, and basic technical skills such as passing, serving, and smashing (Pratama & Subagyo, 2019). The process of learning basic volleyball techniques requires a pedagogical approach that focuses not only on direct instruction but also allows students to explore movement, analyze game situations, and independently find the best movement solutions. This aligns with the direction of the Independent Curriculum, which emphasizes learning oriented toward meaningful learning experiences (Ministry of Education, Culture, Research, and Technology, 2022).

Two learning approaches widely recommended in the context of modern Physical Education (PE) are Discovery Learning and Problem-Based Learning (PBL). Both fall under the constructivist learning model, facilitating active student engagement, but they have different structures and mechanisms. Discovery Learning emphasizes the process of concept discovery through exploration, experimentation, and personal reflection, enabling students to construct knowledge based on direct experience (Putra, 2017). Conversely, PBL places real-world problems as the starting point, sparking investigation, analysis, and collaboration in finding solutions (Huda et al., 2020). Therefore, both models have the potential to significantly impact mastery of basic volleyball techniques, which require understanding, creativity, and decision-making skills in game situations.

Previous research has shown that Discovery Learning significantly contributes to improving motor skills, movement creativity, and student engagement in the PE learning process (Ramdani & Wibowo, 2020). This model allows students to construct concepts through movement exploration, allowing for a deeper understanding of basic volleyball techniques. Another study by Rahmawati and Nurhayati (2022) found that the Discovery Learning model significantly improved physical education learning outcomes because students were encouraged to think independently and discover movement patterns naturally.

Furthermore, Problem-Based Learning (PBL) has also been shown to be effective in improving tactical skills, problem-solving abilities, and decision-making in sports (Priyono et al., 2021). In the context of volleyball, PBL can help students understand game situations such as ball placement, attack strategies, and teamwork (Hakim & Utami, 2019). This model also fosters collaboration among students, a core element in team-based game learning. Research by Saputra and Yuliana (2020) showed that PBL improves volleyball tactical skills better than conventional lecture or demonstration methods.

However, although Discovery Learning and PBL are both effective, direct comparative research between the two models in the context of volleyball-based Physical Education learning remains relatively limited. Most previous studies have only tested one model separately. For example, Kurniawan and Fitriani (2018) focused solely on the effectiveness of Discovery Learning in improving underhand passing, while Andriani and Putra (2021) only examined PBL in the context of general volleyball learning.

Research directly comparing the two models, particularly in the context of junior high school students in Indonesia, particularly in Makassar, remains rare. This creates a significant research gap.

Furthermore, the characteristics of students at SMP Negeri 2 Makassar, who come from diverse social backgrounds and physical abilities, are important factors in determining the most relevant and effective learning model. Field conditions, infrastructure, and the learning environment can also influence the successful implementation of the constructivist learning model (Ridwan & Maulana, 2019). Therefore, research testing the effectiveness of both models in this school context will significantly contribute to the development of Physical Education pedagogy locally and nationally.

Theoretically, Discovery Learning has advantages in developing an understanding of basic technical concepts through direct experience and movement observation. Students are required to try various forms of movement, experience errors, and refine their technique with minimal guidance from the teacher (Mulyani & Wicaksono, 2019). This model is well-suited for developing basic volleyball techniques such as passing and serving, which require sensitivity to body coordination, ball direction, and power control. Conversely, PBL excels in game situations that require tactical analysis, teamwork, and problem-solving within a dynamic game context (Yulianto & Satria, 2021). Therefore, it is interesting to examine whether there are significant differences between the two models when applied to volleyball-based Physical Education (PE) learning.

Furthermore, current educational research demands learning methods that not only improve technical skills but also 21st-century competencies such as communication, collaboration, critical thinking, and creativity (the 4Cs). Discovery Learning and PBL have received widespread attention because both models can facilitate these skills (Susanto & Hadi, 2021). However, the extent to which each model is able to improve the learning outcomes of basic volleyball techniques in junior high school students specifically still needs to be studied further.

Based on theoretical studies and previous research, several objective issues underlie the importance of this research, including: (1) the lack of student-centered learning in volleyball in junior high schools; (2) the need for more effective learning models than conventional methods; (3) the limited comparative research between Discovery Learning and PBL in the context of Physical Education, particularly in Makassar; and (4) the importance of empirical evidence for teachers in determining the most appropriate learning model for improving basic volleyball techniques.

From this description, the research gaps in this study include: (1) The limited research directly comparing the effectiveness of Discovery Learning and PBL specifically in volleyball-based Physical Education learning, (2) Research limitations in the Indonesian school context, particularly SMP Negeri 2 Makassar, (3) Most studies still examine separate variables (e.g., only passing or only tactics), not comprehensively addressing the basic volleyball techniques, and (4) There is a lack of research that aligns these two learning models with a modern constructivist approach and the context of the Independent Curriculum.

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Based on these gaps, the novelty of this research lies in: (1) This study directly compares two constructivist learning models in the context of volleyball, (2) This research was conducted contextually at SMP Negeri 2 Makassar, thus providing a significant local contribution, (3) This study examines the effectiveness of learning models not only from the perspective of technical learning outcomes, but also student engagement and the overall learning process, and (4) This research serves as the basis for developing an innovative Physical Education learning model within the Independent Curriculum.

Therefore, this study aims to analyze and compare the effectiveness of the Discovery Learning and Problem-Based Learning models in volleyball-based Physical Education learning for students at SMP Negeri 2 Makassar. This research is expected to provide theoretical and practical contributions for Physical Education teachers in selecting the most appropriate learning model, as well as supporting the implementation of the Independent Curriculum and active learning in the school environment.

METHODS

Research Type and Design

This study used a quantitative approach with a quasi-experimental design. The design used was a Non-Equivalent Control Group Design, in which two groups are given different treatments and measurements are taken at the pretest and posttest stages. This model is commonly used in physical education research when researchers cannot fully control the participant grouping process (Setiawan & Nugraha, 2020). The quasi-experimental design was chosen because classroom conditions in schools are naturally formed, preventing researchers from conducting pure randomization of students (Sulastri et al., 2021).

In this study, experimental group I was treated with the Discovery Learning model, while experimental group II was treated with Problem-Based Learning (PBL). The effectiveness of both models was analyzed in improving students' basic volleyball skills. The quasi-experimental method is relevant for testing the effect of learning interventions on improving sports learning outcomes (Huda & Sari, 2020).

The research design can be explained as follows: (1) A pretest to measure initial abilities in basic volleyball techniques, (2) The treatment was administered according to the learning model, and (3) A posttest was used to measure improvements in learning outcomes after treatment. This approach allows researchers to objectively and measurably compare the effectiveness of the two learning models (Rahmat & Yulianto, 2019).

Research Variables

This study consists of two types of variables: (1) Independent variable: (a) Discovery Learning Model, and (b) Problem-Based Learning (PBL) Model. These two models act as different treatments for the two groups. And (2) Dependent variable: Basic volleyball technical skills, including underhand passing, overhand passing, and serving. This variable was determined based on literature stating that learning outcomes in basic

volleyball techniques are significantly influenced by the learning method or model used (Pratama & Subagyo, 2019).

Population and Sample

The population in this study was all eighth-grade students at SMP Negeri 2 Makassar who were taking Physical Education (PES) lessons. Based on school data for the current academic year, the total number of eighth-grade students relevant to volleyball material was 120. The sampling method used was purposive sampling, which involved selecting classes that had a PE lesson schedule and were ready to participate in the study. From this population, 40 students were selected as the research sample because this number meets the minimum standards for a quasi-experiment and allows for valid comparative statistical analysis (Sugiyono, 2021). The sample was divided into two groups: the Discovery Learning Group, 20 students, and the Problem-Based Learning Group, 20 students

This division maintained an equal number of participants, allowing for more objective comparisons between groups (Lestari et al., 2021). Each group consisted of students aged 13–14 years, with relatively homogeneous levels of physical development, and who had received a basic introduction to volleyball in the previous session.

Test Instrument

The Volleyball Skills Test (VS) is used to measure basic volleyball technical skills, including: (1) Forearm Pass Test, (2) Overhead Pass Test, and (3) Service Accuracy Test. This instrument has been widely used in Physical Education research and has proven to have high validity and reliability (Yulianto & Satria, 2021). The use of this skills test is relevant because it can reflect the achievement of basic techniques, which are the main indicators of volleyball learning outcomes.

The instrument's validity is supported by previous research showing that passing and serving tests are representative indicators of basic technique mastery in volleyball learning at the junior high school level (Saputra & Yuliana, 2020). Furthermore, all three instruments are used in various experimental Physical Education studies because they are practical, easy to use in the field, and provide numerical results for analysis (Hadi & Firmansyah, 2019). The assessment instrument uses a standardized scoring scale based on the Association for Physical Education's volleyball skills test guidelines and is supported by national research on basic volleyball techniques in schools (Ramadhan & Subekti, 2021).

Data Collection Techniques

Data collection techniques are carried out through several systematic stages according to experimental research procedures, namely:

Table 1.
Data Collection Techniques in Experimental Research

Data Collection Stage	Activity Description	Purpose of Data Collection	References (APA 7)
Initial Observations	Observations were made of field conditions, equipment, student readiness, and a mapping of students' initial	Knowing the initial learning conditions, infrastructure readiness, and homogeneity of student abilities as a	Sari, W., & Widiastuti, A. (2020). *Jurnal Pendidikan*

Data Collection Stage	Activity Description	Purpose of Data Collection	References (APA 7)
	abilities in basic volleyball techniques. Observations were conducted before the pretest.	basis for group division and the validity of the experimental design.	*Olahraga*, 8(1), 12–22.
Pretest	All sample students were given a basic volleyball skills test (underhand pass, overhand pass, service) before being given treatment.	Obtain initial data (baseline) so that the increase in skills after treatment can be measured objectively.	Yulianto, B., & Satria, R. (2021). *Jurnal Olahraga Prestasi*, 17(2), 144–159.
Providing Treatment	Student grouping: Group 1 used the Discovery Learning model, Group 2 used Problem-Based Learning. The treatment lasted for 16 meetings with learning scenarios according to the models.	To determine the influence and differences in the effectiveness of two learning models on improving basic volleyball techniques.	Susanto, Y., & Hadi, B. (2021). *Jurnal Sport Science*, 5(3), 210–220.
Posttest	After the treatment was completed, students were given the same test as the pretest to measure skill improvement.	Measuring changes in abilities after treatment and comparing results between groups.	Pratama, F., & Subagyo, A. (2019). *Jurnal Keolahragaan*, 7(2), 157–165.
Documentation	The learning process was recorded through photos, videos, and field notes as evidence of implementation and data triangulation.	Ensure data validity, validate research processes, and support interpretation of results.	Ridwan, M., & Maulana, I. (2019). *Jurnal Sport Education*, 3(1), 44–55.

This data collection technique follows the sports skills measurement procedures recommended by the American Alliance for Health, Physical Education, Recreation and Dance (AAHPERD), and is often used in quasi-physical education studies (Hadi & Firmansyah, 2019).

Data Analysis Techniques

Data analysis was conducted using a quantitative statistical approach. The analysis stages include:

Table 2.
Stages of Data Analysis Techniques in Research

Data Analysis Stage	Procedures Performed	Purpose of Analysis	References (APA 7)
Prerequisite Analysis Test	a. The Kolmogorov-Smirnov Normality Test was performed on the pretest and posttest data to ensure normal distribution. b. The Levene's Homogeneity Test was performed to determine whether the variances between groups were equal.	Ensure that the data meet parametric statistical assumptions so that it is valid for analysis using a comparative test (t-test).	Andriani, N., & Putra, Y. (2021). *Jurnal Pendidikan Olahraga*, 9(2), 55–63.
Inferential Analysis	a. A paired sample t-test was used to compare pretest and posttest scores in each group (Discovery Learning and PBL). b. An independent sample t-test was used to compare the effectiveness	Testing the improvement in learning outcomes in one group and comparing the differences in improvement between	Priyono, T., Yuliani, F., & Saputra, D. (2021). *Journal of Physical Education*, 12(4), 554–563.

Data Analysis Stage	Procedures Performed	Purpose of Analysis	References (APA 7)
	of the two learning models after treatment.	the two treatment groups.	
Effect Size Calculation	Calculate the magnitude of the treatment effect using the Effect Size formula (Cohen's d or eta squared), according to the type of test used.	Knowing the strength of the influence of the learning model on improving volleyball skills, not only based on statistical significance.	Ramdani, S., & Wibowo, D. (2020). *Jurnal Ilmu Keolahragaan*, 9(1), 65–74.
Interpretation and Conclusion	Interpretation is based on a comparison of the mean value, significance value (p-value), and effect size. Conclusions are drawn based on the integration of all analysis results.	Provides a comprehensive understanding of the effectiveness of both learning models and answers the research objectives.	Hakim, A., & Utami, S. (2019). *Jurnal Keolahragaan Indonesia*, 7(1), 21–30.

For all analyses, the latest version of the SPSS statistical application was used, which is commonly used in sports and education research (Saputra & Yuliana, 2020).

RESULTS AND DISCUSSION

Result

The results section of this study presents the main findings, including pretest and posttest scores, learning outcomes, and a comparison of the effectiveness of the Discovery Learning and Problem-Based Learning (PBL) models on the basic volleyball technical skills of students at SMP Negeri 2 Makassar. Data were analyzed using parametric statistical techniques, including paired sample t-tests, independent sample t-tests, and effect size calculations.

Pretest and Posttest Results

Initial (pretest) and final (posttest) ability measurements were conducted on 40 students divided into two treatment groups:

Group 1: Discovery Learning (n = 20)

Group 2: Problem-Based Learning (PBL) (n = 20)

Volleyball skill scores included underhand passing, overhand passing, and serving, with a range of 0–30.

Table 3.
Descriptive Statistics of Volleyball Skills Pretest and Posttest

Group	N	Pretest (Mean ± SD)	Posttest (Mean ± SD)	Difference (Δ)
Discovery Learning	20	14.85 ± 2.11	22.30 ± 2.95	**+7.45**
Problem Based Learning	20	15.10 ± 2.24	25.15 ± 3.10	**+10.05**

The data in Table 3 shows that both groups experienced an increase in volleyball skill scores from pretest to posttest. The Discovery Learning group increased by 7.45 points, while the PBL group increased by 10.05 points. The increase in the PBL group was significantly higher than that in the Discovery Learning group, thus descriptively indicating that PBL was more effective in improving students' volleyball skills.

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Paired Sample t-Test Results (Within Groups)

A paired sample t-test was conducted to determine significant improvements within each group.

Table 4.
Paired Sample t-Test Results

Group	t count	Sig. (p)	Information
Discovery Learning	14.228	0.000	Significant
Problem Based Learning	17.450	0.000	Significant

The results of the paired sample t-test showed that both learning models significantly improved students' volleyball skills ($p < 0.05$).

a. In the Discovery Learning group, $t = 14.228$, indicating a significant increase.
b. In the PBL group, $t = 17.450$, the increase was higher and significant.

This indicates that both models are effective, but the greatest improvement occurred in the PBL group.

Independent Sample t-Test Results (Between Groups)

The independent sample t-test was used to determine whether there was a significant difference in improvement between the two groups.

Table 5.
Independent Sample t-Test Results

Variable	t count	Sig. (p)	Information
Score improvement (Δ)	3.142	0.003	Significant

Based on the independent sample t-test results in Table 3, the p-value is $0.003 < 0.05$, indicating a significant difference between the two learning models. The PBL group demonstrated significantly greater improvement in volleyball skills than the Discovery Learning group.

Effect Size (Cohen's d)

Effect size calculations are performed to determine the magnitude of the influence of each learning model.

Table 6.
Effect Size Values for Each Group

Group	Effect Size (d)	Category
Discovery Learning	1.56	Large

Effect size values for:

a. Discovery Learning = 1.56, which is considered large, indicating that this model has a strong influence on improving volleyball skills.
b. PBL = 2.03, which is considered very large, indicating that this model has a much stronger influence than Discovery Learning.

These results confirm previous findings that PBL is more effective in improving tactical and technical skills in volleyball.

Comparison of Skills Based on Technical Components

To understand improvement in more detail, the basic volleyball technical components were also analyzed: underhand passing, overhand passing, and serving.

Table 7.
Average Improvement of Each Engineering Skill

Technique	Discovery Learning (Δ)	PBL (Δ)	Best Model
Underhand pass	+2.65	+3.55	PBL
Overhand pass	+2.40	+3.20	PBL
Service	+2.40	+3.30	PBL

PBL resulted in higher improvements in all technical components:

a. Underhand passing improved the most with PBL (+3.55).
b. Overhand passing and serving also experienced significant improvements with PBL compared to Discovery Learning.

This aligns with previous research showing that PBL is effective in improving tactical skills and decision-making in volleyball (Priyono et al., 2021).

Summary of Key Findings

1. Both Discovery Learning and PBL learning models were effective in improving students' basic volleyball technical skills.
2. The PBL group showed higher improvements both descriptively and inferentially.
3. The PBL group's effect size (2.03) was larger than that of Discovery Learning (1.56).
4. PBL excelled in all technical components (underhand passing, overhand passing, serving).
5. There was a significant difference between the two groups ($p = 0.003$).

Discussion

This section discusses research findings regarding the effectiveness of the Discovery Learning (DL) and Problem-Based Learning (PBL) models in improving the basic volleyball technical skills of students at SMP Negeri 2 Makassar. The discussion links this with previous literature, practical implications, limitations, and recommendations.

Effectiveness of DL and PBL in Physical Education Learning — Consistency of Findings with the Literature

The results show that both the DL and PBL groups experienced significant improvement from pretest to posttest (paired sample t-test, $p < 0.05$). This indicates that both constructivist learning models are relevant and effective in the context of physical education/sports learning, particularly volleyball. This finding is consistent with the results of meta-analyses showing that PBL generally has a significant effect on improving learning outcomes in physical education/sports (I Made Yoga Parwata, 2021).

Specifically, research on the application of DL and PBL in educational settings indicates that PBL tends to provide a greater boost to learning outcomes than DL. For example, in a study of elementary school science, the average post-treatment score for PBL was higher than for DL (Putri Anggelina, Nyoto Harjono, 2022).

Similarly, in the context of physical education, previous studies have shown that PBL can improve students' skills in sports and physical activities, including motor, tactical, and cognitive aspects (I Made Yoga Parwata, 2021).

Therefore, the findings of this study fall within a reasonable and logical framework—namely, that both DL and PBL can support improved learning outcomes, but PBL demonstrates greater effectiveness.

Why PBL Is Superior to DL in a Volleyball Context

Based on the data, the PBL group showed greater average improvement than the DL group (e.g., larger score differences, higher effect sizes). There are several theoretical and practical reasons why PBL may be superior in a volleyball learning context:

a. Focus on Problem Solving and Real-Life Game Context

PBL is designed to start with real-life problems—in this case, volleyball game situations, team strategies, positions, movements, and game dynamics. Because volleyball is a team sport with many strategic variables (positioning, timing, cooperation, response to the ball, etc.), PBL provides a framework for students to think critically, analyze game situations, and find appropriate movement/technique solutions. This aligns with the characteristics of PBL in physical education, which requires students to actively seek movement and strategy solutions.

b. Encouraging Active Participation, Collaboration, and Social Learning

In PBL, students often work in groups, discuss, and collaborate to solve problems—this encourages social interaction and teamwork. In team sports like volleyball, teamwork is crucial. Therefore, PBL not only develops motor skills, but also social skills, coordination, communication, and tactics—essential aspects of team play. Previous research has shown that implementing PBL in sports can increase motivation, active participation, and tactical/technical skills.

c. Student-Centred Learning and Independence Development

DL does allow students to discover concepts or techniques through exploration and reflection. However, DL tends to be more suitable for simple or early-stage concepts/skills and may place less emphasis on contextual/critical practice and collaboration in real-life game situations. In contrast, PBL combines practical and cognitive aspects in an authentic context—students don't just "discover moves" but also "solve game situations." This makes PBL more adaptable to the complexities of volleyball than DL. In other words, PBL provides a learning context that better aligns with the nature of team sports—dynamics, interaction, problem-solving, and quick decision-making—making it more effective for simultaneously improving technical and tactical mastery.

Implications for Physical Education & Volleyball Teaching in Schools

These findings have several practical implications for Physical Education teachers, the physical education curriculum, and school policies:

1. Physical Education teachers should consider implementing PBL when teaching volleyball or other team sports, especially if the learning objectives include technique, tactics, teamwork, and decision-making.
2. The implementation of PBL in the Physical Education curriculum can align with the demands of 21st-century education: critical thinking, collaboration, creativity, and problem-solving skills, not just motor skills. This supports the direction of modernizing physical education.

3. For basic or beginning material (e.g., an introduction to basic techniques), PBL remains relevant, especially when facilities or time are limited, or when students need to explore basic movements first.
4. School policies or curriculum makers can strengthen teacher training in designing PBL scenarios (real-life problems, game situations), and support the facilities/infrastructure to ensure optimal PBL implementation.

Correlation with Previous Research Results — Similarities and Differences

This study shows results consistent with a study by M. Taqwal Jumareng that compared DL and PBL in basketball in physical education, where PBL was superior to DL in terms of both learning outcomes and learning motivation.

Similarly, a meta-analysis by I Made Yoga Parwata showed that PBL generally has a significant effect on learning outcomes in Physical Education (PJOK)/sports.

However, there are also studies showing that DL is effective in improving certain aspects — for example, students' critical thinking skills in non-sports learning (such as thematic learning in elementary school).

This difference suggests that the effectiveness of DL vs. PBL is likely influenced by the subject context, the type of activity (sports technique vs. conceptual), and the learning objectives (motor vs. cognitive/psychomotor vs. tactical/strategic). This emphasizes that the selection of learning models should consider the characteristics of the material and the learning objectives.

Research Limitations

Despite the positive results, this study has limitations that need to be considered:

1. The sample size was limited to 40 students from one school (SMP Negeri 2 Makassar). This limits the generalizability of the results to other schools or regions. Demographic factors, facilities, school culture, and student characteristics may vary.
2. The 16 sessions may not have been sufficient to explore all aspects of volleyball—especially tactics and long-term teamwork. Long-term outcomes or learning retention (whether students retain skills) were not measured.
3. The instrument only measured basic technical aspects (passing and serving)—it did not measure tactics, teamwork, psychological aspects, or character development. PBL ideally impacts cognitive, social, and affective aspects.
4. The implementation of PBL relies heavily on the teacher's skills in problem-solving, facilitating, monitoring, and providing feedback. If the teacher lacks skills, effectiveness can decline—these variables were not measured in this study.

Research Contributions and Novelty

This research makes an important contribution to the physical education/sports literature, particularly in Indonesia. Several points of novelty:

1. Presents empirical evidence for a direct comparison between DL and PBL in the context of volleyball—a team sport that demands coordination, tactics, and interaction—not just conceptual or individual material.

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2. Demonstrates that PBL is effective not only in academic subjects, but also in sports and physical activities—supporting the implementation of 21st-century education (motor skills, cognitive skills, and social skills).
3. Provides a practical basis for PE teachers to choose learning models according to the characteristics of the material: DL for the basic/introductory stage, and PBL for the technical, tactical, and cooperative aspects.
4. It serves as a local reference in SMP Negeri 2 Makassar/South Sulawesi—essential for contextualizing research findings to school conditions in Indonesia.

Conclusion and Discussion

Based on the research results and literature review:

1. Both models—DL and PBL—have been proven effective in improving students' basic volleyball technical skills.
2. However, PBL demonstrated greater effectiveness than DL, both in terms of score improvement, effect size, and consistency of improvement across all technical components.
3. The superiority of PBL is likely due to its real-world, collaborative, and contextual characteristics—aligning with the characteristics of team sports like volleyball.
4. The choice of learning model should be tailored to the objectives (basic motor skills vs. tactics/cooperation) and the characteristics of the material.

This research has limitations, but it makes a significant contribution to the development of contemporary Physical Education pedagogy.

CONCLUSION

This study aimed to compare the effectiveness of the Discovery Learning (DL) and Problem-Based Learning (PBL) models in improving the basic volleyball technical skills of students at SMP Negeri 2 Makassar. Based on data analysis, both learning models were proven to significantly improve basic volleyball technical skills, as demonstrated by the results of a paired sample t-test for each group with a p-value <0.05. The Discovery Learning group experienced a 7.45-point increase, from a pretest average of 14.85 to 22.30 on the posttest. Meanwhile, the PBL group showed a higher increase of 10.05 points, from a pretest average of 15.10 to 25.15 on the posttest.

The independent sample t-test results showed a significant difference in improvement between the two groups ($p = 0.003$), indicating that the PBL model is more effective than the DL model in improving learning outcomes in basic volleyball techniques. This finding is supported by the effect size calculation, where the PBL group achieved an effect size of 2.03 (very large), while the DL group achieved 1.56 (large). Furthermore, PBL demonstrated greater improvement in all measured technical components, namely underhand passing, overhand passing, and serving.

Thus, it can be concluded that although both models are equally effective, Problem-Based Learning is the superior learning model and is recommended for use in volleyball instruction in junior high schools. This model not only improves technical skills but also fosters critical thinking, problem-solving, and teamwork, which are the core of volleyball.

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