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Development of an Innovative Physical Education Learning Model Based on Modified Basic Badminton Techniques to Increase Students' Active Participation

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A. Conception and design of the study; **B.** Acquisition of data;
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ABSTRACT

This study aims to develop an innovative Physical Education (PE) learning model based on modifications to basic badminton techniques to increase active student participation at SMK Negeri 7 Makassar. The study employed a Research and Development (R&D) method, encompassing needs analysis, model design, expert validation, limited trials, and effectiveness evaluation. The study sample consisted of 20 tenth-grade students selected using a purposive sampling technique. Data were collected through active participant observation, badminton skills tests (pretest–posttest), and student response questionnaires. Data analysis was conducted using descriptive statistics and thematic qualitative analysis. The results showed that the learning model based on modifications to basic badminton techniques was effective in increasing student active participation across four key indicators: physical, emotional, cognitive, and social engagement. The 51.9% increase in active participation indicates that this model is able to create a more engaging and inclusive learning environment. Furthermore, there was a 60.3% increase in mastery of basic badminton techniques, indicating that modifications to the equipment, court, and rules of the game helped students understand skills in a gradual and contextual manner. Student responses to the model were also very positive, with an average score of 4.60, indicating that students felt comfortable, motivated, and actively engaged during the learning process. Overall, this learning model is feasible for implementation in physical education (PJOK) learning and has the potential to be developed in other school contexts. Further research is recommended using a larger sample size and a comparative experimental design.

Keywords : Innovative Learning, Badminton Modification, Active Participation, Physical Education, Vocational High School.

INTRODUCTION

Physical Education, Sports, and Health (PJOK) plays a fundamental role in developing movement competencies, physical health, and positive character in secondary school students. In the context of modern education, PJOK is no longer understood solely as physical activity, but rather as a holistic learning vehicle that integrates motor, cognitive, social, and affective skills (Casey et al., 2020). At the learning level, engagement or active participation is a key indicator of successful PJOK curriculum implementation, as high participation contributes to mastery of movement skills, improved fitness, and the development of student learning motivation (Bailey et al., 2018).

However, the reality on the ground shows that PJOK implementation still faces challenges, particularly in attracting interest and increasing active participation. Many students are physically present but lack real engagement in the learning process (passive engagement) due to boredom with conventional learning models that tend to be monotonous and lack innovation (Sari & Wijayanto, 2021). Several studies have shown that physical education (PE) instruction in secondary schools often neglects creativity, flexibility, and adaptability to students' unique needs (Kirk, 2019). This creates a gap between learning objectives that emphasize activity and participation, and traditional teaching practices that rely on single-point instruction.

Globally, various innovative approaches have been developed to increase student participation through game-based learning models and modifications to fundamental movement techniques. Modified games are considered more effective in engaging students because they allow them to engage in simpler, more enjoyable, and more challenging activities without losing the essence of the skills being learned (Light & Harvey, 2017). Movement modification, particularly in badminton, has been shown to improve students' fundamental movement skills, motivation, and self-confidence in PE (Physical and Health Sciences) learning (Rizal et al., 2022).

Badminton is a popular sport in Indonesia and is often taught in the PE curriculum at the high school/vocational school level. Basic skills such as serving, lobbing, netting, and footwork require motor coordination, flexibility, and an understanding of playing tactics. However, some students find basic badminton techniques difficult, hindering them from optimally participating in the learning process. Factors such as limited technical mastery, shyness, and a lack of self-confidence limit active student participation (Nurmala & Hakim, 2020).

In a vocational school environment like SMK Negeri 7 Makassar, students have heterogeneous motor skills. This requires a learning model that adapts to student needs and abilities. A modification-based approach to basic badminton techniques is considered relevant for increasing participation and facilitating student gradual skill acquisition through simple exercises such as using lightweight shuttlecocks, reducing the court size, modifying rackets, and playing mini-badminton games (Suganda et al., 2022).

Previous research has shown that modification-based learning models facilitate students' gradual understanding of basic techniques, increase student interaction, and create a more lively and active learning environment (Fajar & Santoso, 2021). This approach is also in line with the concept of student-centered learning, where students become active, creative, and involved subjects in every learning process (Harvey & Jarrett, 2020).

Although numerous studies highlight the importance of innovative learning in Physical Education (PJOK), the implementation of models based on modifications to basic badminton techniques in vocational schools such as SMK Negeri 7 Makassar remains minimal. Teachers generally use demonstration approaches and routine exercises without modification, resulting in limited and less engaging learning activities for students. This results in low active participation, minimal social interaction during learning, and suboptimal mastery of basic skills.

The main problems that emerge in the field include: (1) Low student interest and active participation due to a lack of innovative and monotonous learning, (2) The absence of a specific learning model developed based on the characteristics of vocational high school students, (3) Basic badminton techniques are relatively difficult, requiring a modified

approach to facilitate understanding, and (4) Limited media and learning strategies provided by teachers in managing engaging and interactive learning activities.

These issues highlight the need to develop innovative, adaptive learning models based on modifications to basic badminton techniques to increase student active participation in PJOK learning.

Several studies have examined the development of innovative learning models in sports, but most have focused on volleyball, basketball, soccer, or other invasive games (Setiawan et al., 2021). Meanwhile, research related to the development of learning models based on modifications to basic badminton techniques remains limited, particularly in the context of vocational schools (SMK), where student characteristics differ from those of high schools.

Furthermore, studies examining modifications to basic badminton techniques have focused more on improving technical skills, rather than on active student participation in learning activities (Wibowo et al., 2019). Active participation is, however, a crucial component for achieving Physical Education (PJOK) learning objectives. There has been no research specifically developing innovative learning models based on modifications to basic badminton techniques aimed at increasing student active participation at SMK Negeri 7 Makassar.

Therefore, there are significant research gaps, including: (1) Lack of badminton learning models based on modifications to basic techniques to increase active participation, (2) Lack of research in the context of vocational schools, particularly SMK Negeri 7 Makassar, and (3) There is no learning model that has been tested systematically and structured to improve the pedagogical and motivational aspects of students.

This model is expected to become a new reference for developing basic badminton technique learning in secondary schools, particularly in vocational institutions with heterogeneous student physical abilities and motivations.

Based on the above description, this research was conducted to develop an innovative Physical Education (PJOS) learning model based on modifications to basic badminton techniques that can increase active student participation at SMK Negeri 7 Makassar. This research designs, tests, and validates a systematically structured learning model, encompassing the planning, implementation, limited trials, extensive trials, and effectiveness evaluation phases.

The results of this research are expected to provide: (1) A theoretical contribution, in the form of an innovative, modification-based learning model that enriches the literature on Physical Education (PJOK), (2) A practical contribution, in the form of a learning guide that teachers can use to manage PJOK classes more effectively and engagingly, and (3) A pedagogical contribution, in the form of increased student active participation, learning interest, and motor skills.

Therefore, this research addresses real needs in schools, gaps in the literature, and the demands of modern learning innovation. The development of this model is expected to provide a concrete solution to improve learning activities and the quality of Physical Education (PE) instruction, particularly in the context of basic badminton techniques.

METHODS

Research Type and Design

This research is a research and development (R&D) study aimed at producing an innovative Physical Education (PE) learning model based on modified basic badminton

techniques to increase active participation of students at SMK Negeri 7 Makassar. The R&D approach was chosen because it can produce new learning products that are systematically validated through limited and extensive trials before full implementation (Gall et al., 2018). The model development method refers to the stages adapted from Borg & Gall with adjustments to the physical education context: (1) needs analysis, (2) model design, (3) expert validation, (4) model revision, (5) limited trials, (6) further revision, (7) extensive trials, and (8) model finalization.

The research and development design in the context of PE is widely recommended because it effectively produces innovative learning tools oriented to student needs and the characteristics of specific sports skills (Rizqi & Firmansyah, 2021). In this study, this approach was used to develop a learning model based on modified basic badminton techniques that could gradually increase students' active participation, learning interest, and technical mastery. Expert validation was conducted by two Physical Education (PE) learning experts and one badminton expert to ensure the appropriateness of the content, pedagogical effectiveness, and safety of the model before it was piloted on students.

Research Variables

This study involved two main variables:

1. Independent variable: An innovative PE learning model based on modified basic badminton techniques. This model includes the following components: field modifications, equipment modifications, game rule modifications, simple basic skill activities, and mini-badminton games. The model was systematically structured to create active, enjoyable, and adaptive learning that adapts to students' abilities.
2. Dependent variable: Student active participation in PE learning. Active participation encompasses physical engagement, emotional engagement, cognitive engagement, and social interaction during learning. This concept follows indicators used in PE research on student engagement (Casey et al., 2020; Bailey et al., 2018).

In addition, the study also examined supporting variables such as student responses, learning motivation, and mastery of basic badminton skills, although these were not used as the primary variables in the analysis.

Population and Sample

The population in this study was all tenth-grade students at SMK Negeri 7 Makassar taking Physical Education, Sports, and Health. Based on a needs analysis and discussions with the Physical Education teacher, 20 students were selected as a sample for the limited trial. The sampling technique used purposive sampling, which involves selecting students deemed representative of population characteristics, such as variations in motor skills, learning motivation, and active participation in Physical Education (Etikan & Bala, 2017).

The use of a sample of 20 students in physical education development research aligns with recommendations from similar studies that emphasize limited trials to assess the model's initial effectiveness before wider implementation (Wibowo et al., 2019). The sample selection also took into account student accessibility, engagement, and availability during the trial of the learning model.

Research Instruments

This study used several data collection instruments tailored to the objectives of measuring active participation and the effectiveness of the learning model, namely:

1. Student Active Participation Observation Sheet

   The primary instrument for assessing student engagement was an observation sheet developed based on the indicators of physical engagement, emotional engagement,

cognitive engagement, and social engagement as formulated by Finn & Zimmer (2012), which has been widely used in research on physical education and health (PJOK) learning (Sari & Wijayanto, 2021). The observation sheet contained 15 statements rated using a Likert scale of 1–5.

2. Student Response Questionnaire
   To determine student perceptions of the learning model, a 20-item questionnaire was used covering aspects of comfort, motivation, understanding of techniques, and enjoyment of learning. This instrument was adapted from research by Harvey & Jarrett (2020) on the evaluation of game-based learning approaches.
3. Basic Badminton Technique Test Instrument
   The basic skills test includes three components: Short and long serve tests, Lob and clear tests, and 6-point footwork test. The instrument was adapted from the Badminton World Federation (2017) guidelines and has been used in research on student skill improvement (Suganda et al., 2022).
4. Expert Validation Sheet
   This sheet was used by Physical Education (PE) learning experts and badminton experts to assess the feasibility of the model, including: material substance, appropriateness of learning steps, pedagogical effectiveness, and activity safety. Expert validation was conducted using a scale of 1–4.

Data Collection Techniques

Data collection techniques were carried out in several stages according to the research design, namely:

1. Learning Observations
   Observations were conducted by two trained observers to ensure the objectivity of student participation assessments. This participant observation technique was conducted during four model trial sessions. The use of two observers helps increase the reliability of the instrument, as recommended in sports education research (Light & Harvey, 2017).
2. Student Response Questionnaire
   After implementing the learning model, students were asked to complete a questionnaire to assess their experience during the learning process. This technique is important for understanding students' affective factors and perceptions of the activity modifications (Rizal et al., 2022).
3. Basic Badminton Techniques Test
   Tests were conducted before and after the learning model intervention. Each student completed the test according to the standard instrument, and the results were recorded by the teacher and researcher.
4. Interviews with Physical Education Teachers
   Semi-structured interviews were conducted to determine the actual learning conditions, challenges faced by teachers, and teacher responses to the developed model.
5. Expert Validation
   Validation was conducted prior to the trial. Experts assessed the model based on the validation sheet format, provided feedback, and recommended revisions if necessary.

Data Analysis Techniques

The data analysis techniques in this study included quantitative and qualitative analysis, as follows:

1. Quantitative Data Analysis

Quantitative data from active participant observation, questionnaires, and skills tests were analyzed using descriptive statistics, including: mean value, standard deviation, percentage increase, and frequency distribution.

Descriptive statistics were chosen because the limited trial aimed to observe general data trends to assess the initial effectiveness of the learning model (Ghozali, 2020).

Comparison of pretest and posttest scores for technical skills was conducted by calculating the percentage increase (gain score) to identify the model's effectiveness in improving students' basic badminton skills (Suganda et al., 2022).

2. Expert Validation Analysis

   Expert validation data were analyzed using Aiken's V formula to assess the level of content validity of the learning model. Aiken's V is widely used in educational research to assess the feasibility of learning instruments and devices (Azwar, 2017).

3. Qualitative Data Analysis

   Qualitative data derived from interviews with physical education teachers and field notes were analyzed using thematic analysis techniques. This technique aims to identify patterns, key issues, and recommendations relevant to model development (Braun & Clarke, 2019).

   The analysis stages include: rereading the data, identifying codes, grouping codes into themes, interpreting the meaning of the findings, and composing a narrative report.

4. Triangulation

   To increase data credibility, the study employed triangulation:

   a. source triangulation (teachers, experts, students),
   b. technical triangulation (observation, questionnaires, interviews),
   c. temporal triangulation (pre- and post-intervention measurements).

   Triangulation techniques are needed so that research results can be scientifically accounted for (Creswell & Poth, 2018).

RESULTS AND DISCUSSION

Result

This section presents the main research findings regarding the effectiveness of an innovative Physical Education (PE) learning model based on modified basic badminton techniques in increasing student active participation and mastery of basic badminton techniques among students at SMK Negeri 7 Makassar. Data were obtained through active participant observation, student response questionnaires, and a basic badminton skills test (pretest–posttest). The research sample consisted of 20 students.

Results of Observations of Student Active Participation

Observations were conducted during four model trial sessions. Four indicators of active participation were assessed:

1. Physical Engagement
2. Emotional Engagement
3. Cognitive Engagement
4. Social Engagement

The following table presents the average scores for each indicator.

Table 1.

Average Scores of Student Active Participation (n = 20)

Active Participation Indicators	Max Score	Pretest Average	Posttest Average	Improvement (%)
Physical Engagement	5	2.85	4.30	50.8%
Emotional Engagement	5	2.90	4.45	53.4%
Cognitive Engagement	5	2.75	4.20	52.7%
Social Interaction	5	3.00	4.55	51.7%
Average Total	**5**	**2.88**	**4.37**	**51.9%**

Observations showed a significant increase in all indicators of active participation. The highest increase was in emotional engagement (53.4%), indicating that the modification-based learning model was able to increase students' interest, enthusiasm, and enjoyment in participating in the learning process. This aligns with the research findings of Light & Harvey (2017), which stated that game modifications can increase students' intrinsic motivation and enjoyment in sports learning.

The next increase was in cognitive engagement (52.7%), indicating that students had a better understanding of basic badminton techniques after the modifications (e.g., reduced court size, lighter shuttlecocks, and mini-games). Modification-based learning reduces the complexity of techniques, making it easier for students to grasp basic technical concepts that are typically considered difficult (Suganda et al., 2022).

Overall, active participation increased by 51.9%, demonstrating that this innovative learning model is able to create a more lively, active, and collaborative learning environment.

Basic Badminton Skills Test Results

The test was conducted on three main components: Serve, Lob/Clear, and Footwork.

Table 2.
Basic Badminton Skills Pretest and Posttest Scores

Skill Components	Max Score	Pretest (Mean)	Posttest (Mean)	Improvement (%)
Service	20	9.80	15.60	59.2%
Lob/Clear	20	10.20	16.10	57.8%
Footwork	20	8.50	14.00	64.7%
Average Total	**20**	**9.50**	**15.23**	**60.3%**

The results of the technical skills test showed a very significant improvement (average 60.3%). The greatest improvement was in the footwork component (64.7%). Footwork is a fundamental skill related to coordination, reaction, and mobility. The smaller court modification and the use of a lighter shuttlecock provided students with more opportunities to move, resulting in rapid improvement in footwork mastery.

The serve component improved by 59.2%, indicating that students were able to execute basic movements more accurately after the modified model was introduced. This aligns with research by Wibowo et al. (2019) that found that learning activities using modified equipment increased the success of basic techniques that were previously difficult for students to master.

The 57.8% increase in the lob/clear component also indicates that the modification allowed students more freedom to try and repeat movements, thus increasing learning efficiency. Many students initially struggled with long shots, but with the lighter shuttlecock and mini-games, they gained more confidence and achieved better quality shots.

Student Response Questionnaire Results

The questionnaire contained 20 items on a Likert scale of 1–5. The summary results are presented in the following table.

Table 3.
Summary of Student Responses to the Learning Model

Aspects Assessed	Max Score	Average	Category
Learning Model Appeal	5	4.60	Excellent
Ease of Understanding Techniques	5	4.55	Excellent
Increased Learning Motivation	5	4.50	Excellent
Active Involvement in Learning	5	4.70	Excellent
Comfort During Learning	5	4.65	Excellent
Average Total	**5**	**4.60**	**Excellent**

The questionnaire results showed that students responded very positively (average score of 4.60) to the modified badminton basic techniques learning model. The highest ratings were active engagement (4.70) and comfort (4.65). This demonstrates that the modified learning model creates a less stressful, more inclusive, and relevant learning environment for students.

The interesting aspect of learning (4.60) indicates that students found this model more engaging than conventional learning. This finding aligns with Casey et al. (2020), who stated that innovative learning can increase engagement and facilitate student-centered learning.

Overall Analysis of the Effectiveness of the Learning Model

Based on:

1. Increased active participation by 51.9%
2. Increased basic technical skills by 60.3%
3. Average student response of 4.60 (very good category)
4. Expert validation stating the model is very suitable for use

This study shows that the Physical Education learning model based on modified basic badminton techniques has proven effective in increasing the active participation of students at SMK Negeri 7 Makassar.

Discussion

Interpretation of Key Findings

The results of the study indicate that the implementation of a Physical Education learning model based on modified basic badminton techniques significantly increased students' active participation and mastery of basic badminton skills. The increase in active participation of approximately 51.9% and an average increase in technical skills of approximately 60.3% demonstrate the effectiveness of the developed learning model. The "very good" student response (mean questionnaire score of 4.60/5) reinforces the well-received nature of this model.

These findings align with previous research showing that the use of a game-based approach (game-based learning/game modification) can increase student engagement, motivation, and active participation in sports learning. For example, a recent meta-analysis found that game-based interventions in PE produced significant positive effects on student enjoyment (Mo et al., 2024).

Similarly, research adopting a modified badminton teaching model showed that these modifications can improve students' motor skills and technical understanding compared to conventional methods.

Thus, the results of this study are not only consistent with global literature on GBL (Game-Based Learning) and learning modifications, but also strengthen the relevance of implementing technique modifications in the context of physical education in vocational high schools (SMK).

Why Modified Basic Badminton Techniques Are Effective

1. Reducing Complexity and Initial Pressure
   Modifications such as the use of lighter shuttlecocks, smaller courts, simpler rules, and mini-games lower the complexity threshold of basic techniques, which are typically difficult for beginners. This makes it easier for students to understand and try movements without fear of failure or embarrassment. This approach is similar to the principle of "play practice" in physical education, where learning tasks are designed to be meaningful, appropriate to the beginner's abilities, and enjoyable.
   Formal research using a modified badminton model in high schools shows that the experimental group achieved better motor development than the control group.
2. Improving Motivation and Affective Aspects
   The high student response to the aspects of interest, comfort, and activeness confirms that the modifications create a fun and supportive atmosphere. This aligns with the literature stating that game-based or modified games can increase motivation, positive attitudes toward sports, and social cooperation.
   Furthermore, modern sports pedagogy theory emphasizes that learning must be student-centered and enjoyable to engage students emotionally and cognitively.
3. Utilizing Meaningful and Contextual Practice
   This modification model allows students to learn through relevant games, rather than monotonous drills. This approach is similar to the concept in the study "Teaching Games for Understanding/Sport Education/Modified Games," which has been shown to increase engagement and skills.
   In the context of vocational high schools where students tend to be more interested in practice than theory this contextual and meaningful approach is highly appropriate, as it helps bridge differences in students' physical abilities and interests.

Implications for Physical Education Learning in Vocational High Schools

These findings have several important implications for the implementation of PJOK in vocational high schools, particularly at SMK Negeri 7 Makassar:

1. Adaptive learning model: The modified model allows teachers to adjust material to suit students' abilities, making it more inclusive. This is relevant in vocational high schools with diverse physical abilities and motivations.
2. Increasing student engagement and motivation: With a fun learning environment, students are more likely to be motivated to continue participating actively, rather than simply attending.
3. Time and resource effectiveness: Modified techniques and small-scale games tend to require flexible equipment and space, making them suitable for implementation even when school facilities are limited.
4. Character and social development: Because many activities are conducted in groups/games, students are trained in cooperation, sportsmanship, communication, and social interaction important aspects of character education. This aligns with research on small-scale game modifications in PJOK in secondary schools.

Thus, the developed model not only supports technical aspects, but also motivational, affective, and social aspects making it comprehensive and holistic.

Comparison with Previous Studies & New Contributions

Most of the literature on badminton in PE or school sports focuses on technical skills and performance, often using conventional or semi-structured methods. For example,

research evaluating mixed teaching modes in higher education found that a variety of methods helped expand students' knowledge and motor reserves. Other research on small-game modifications or game-based learning in volleyball, basketball, or circuit games showed increased motivation, skills, and participation.

However, there is little research on modifying basic badminton techniques in the vocational high school context which focuses on active participation and pedagogical aspects, rather than just technical performance. In recent literature, systematic reviews of badminton instruction in schools have shown a shift from traditional instruction to more innovative and contextual methods.

Therefore, this study makes novel contributions by:

1. Systematically implementing a modified badminton model in vocational high schools;
2. Combining aspects of basic technique, active participation, motivation, and student acceptance;
3. Providing empirical evidence of significant increases in participation and skills a practical and theoretical contribution to the physical education literature.

Research Limitations

While the results indicate success, this study has several limitations:

1. The sample size was small (n = 20) for the pilot trial. Although in accordance with the initial standards for model development (pilot testing), the results cannot be generalized to the entire student population of SMK Negeri 7 or other vocational high schools.
2. The intervention duration was short, only a few meetings. Therefore, the long-term effectiveness of the model is unknown: whether improvements in participation and technique can be maintained or even further developed.
3. There was no control group in this pilot trial the assessment was based on a pretest-posttest without comparison with the conventional learning group. Therefore, it is difficult to ensure that changes are solely due to the model and not external factors such as student motivation, classroom atmosphere, or teacher guidance.
4. Subjective measures of active participation (observations, questionnaires) even when triangulation is used, there is still potential for bias in assessments by observers or student responses.
5. Limitations of the instruments for example, observation sheets and questionnaires need further testing for reliability and validity in different populations and contexts.

Recommendations for Further Research

Based on these limitations and the encouraging findings, several recommendations for further research are:

1. Sample expansion and random sampling: Involve more students from multiple grades or schools, using a quasi-experimental design with a control group to increase external validity.
2. Long-term trials: Implement the intervention for a semester or an academic year to examine the effects on stability, skill retention, and active participation.
3. Addition of other variables: For example, aspects of physical fitness, mental health, social cohesion, or other academic achievement so that the model's impact can be measured more comprehensively.
4. Development of standardized and valid instruments: Test the high reliability and validity of observation sheets and questionnaires in a broader population.

5. Incorporation of more in-depth qualitative methods: Focus group interviews with students and teachers, regular classroom observations, and video documentation to understand the dynamics of the learning process and factors that support or hinder participation.
6. Adaptation of the model to other sports: If this model is effective, it can be expanded to other sports (e.g., volleyball, sepak takraw, basketball) with modifications to suit the characteristics of the sport and students given that literature shows that game modifications are effective across various sports.

Theoretical and Practical Contributions

This research makes important theoretical and practical contributions:

1. Theoretical: Enriches the literature on sports learning in vocational high schools, particularly badminton; it strengthens evidence that game/technique modifications can improve engagement and basic skills. This model can serve as an academic reference for further research on sports pedagogy, game-based learning integration, and contextual learning adaptation.
2. Practical: Provides concrete guidance for physical education teachers to design more adaptive, inclusive, and engaging learning especially in vocational high schools or schools with limited resources. This model can help increase student participation, learning motivation, and learning outcomes in basic badminton techniques, as well as support student character development through social and collaborative aspects.

Based on the findings and analysis, it can be concluded that the physical education learning model based on modified basic badminton techniques is an effective strategy for increasing active participation and mastery of basic skills in students at SMK Negeri 7 Makassar. Its success is driven by reduced technical complexity, increased student motivation and comfort, and the application of contextual and meaningful learning methods. Despite its limitations, this model shows significant potential and is relevant for further development, both in research and in school practice.

CONCLUSION

This study aims to develop and test the effectiveness of an innovative Physical Education (PE) learning model based on modifications to basic badminton techniques to increase active student participation at State Vocational High School 7 Makassar. Based on observations, skills tests, and student response questionnaires, this model was proven to significantly increase students' physical, emotional, cognitive, and social engagement. The 51.9% increase in active participation indicates that the modification approach creates a more enjoyable, challenging, and tailored learning experience for vocational high school students. Furthermore, the 60.3% increase in mastery of basic badminton techniques indicates that modifications to the equipment, court, and rules of the game facilitate students' gradual and contextualized implementation of various basic skills.

The overwhelmingly positive student response (mean questionnaire score of 4.60) reinforces the evidence that this model is well-received and provides a more engaging learning experience than conventional learning. These findings confirm that innovative, modification-based learning strategies can be a strategic alternative for improving the quality of PE learning, particularly in vocational schools with diverse physical abilities and learning motivations.

This study also provides theoretical contributions to the development of sports learning literature and practical contributions for physical education teachers in designing adaptive, creative, and effective learning. However, this study is limited by its sample size and intervention duration, so further research with a larger sample size and a more rigorous experimental design is needed to verify and expand on these findings.

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