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The Effect of Jigsaw-Type Cooperative Learning on Motor Skills and Basic Sepak Takraw Techniques in Students

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

This study aimed to analyze the effect of the Jigsaw cooperative learning model on motor skills and basic Sepak Takraw techniques in students at SMPN 13 Makassar. The study used a one-group pretest-posttest design with a sample of 40 students. The instruments used included motor skills tests (agility, coordination, reaction speed, balance) and basic Sepak Takraw techniques tests (serving, control, passing, footwork, and ball contact accuracy). The results showed a significant improvement after implementing the Jigsaw model. For motor skills, the average score increased from 63.20 (pretest) to 78.55 (posttest), representing a 15.35-point increase. A paired sample t-test showed a p-value of 0.000, indicating a significant difference before and after the treatment. The effect size, calculated using Cohen's d, was 1.89, categorized as a very large effect. In the basic Sepak Takraw technique test, the average score increased from 61.64 (pretest) to 78.80 (posttest), representing a 17.16-point increase. All technical components improved, particularly footwork, which increased by 18.5 points. The statistical test results showed a p-value of 0.000, with an effect size of 2.12, which is also considered very large. Overall, the Jigsaw cooperative learning model has proven effective in improving the motor skills and basic Sepak Takraw technical skills of junior high school students. These findings recommend Jigsaw as an alternative learning model capable of improving the quality of Physical Education (PJOK) learning, particularly in Sepak Takraw.

Keywords : Jigsaw; Motor Skills; Basic Techniques; Sepak Takraw; Cooperative Learning.

INTRODUCTION

Physical education and sports in schools play a crucial role in developing motor skills and basic techniques in various sports, as well as shaping students' physical and social character. Sports such as Sepak Takraw require good motor skills, coordination, agility, and mastery of basic techniques such as serving, underhand/overhand serves, passing, footwork, and ball control. Mastery of these basic techniques provides the foundation for students to participate and excel in competitions. Therefore, the learning methods implemented in Physical Education, Sports, and Health (PJOK) lessons significantly determine how optimally students are able to master motor skills and basic sports techniques.

One approach in current education is cooperative learning, which emphasizes interaction between students, cooperation, shared responsibility, and mutual assistance and collaborative learning. Meta-analyses and various studies show that cooperative learning

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can improve learning outcomes not only in the cognitive domain but also in the affective and psychomotor domains.

One popular type of cooperative learning is the Jigsaw (Teaching Technique). The Jigsaw technique is designed for students to learn collaboratively each student is responsible for a specific section of the material, then teaches it back to their group mates. In this way, students become "teachers" for each other, enhancing their understanding and engagement in the learning process.

In the context of physical education and sports, the Jigsaw method offers the potential to facilitate students' mastery of basic movement techniques more effectively through discussions, questions and answers, joint demonstrations, and group practice. This model promises more than just mastery of theory: it also fosters mastery of movement, technique, motor coordination, and increased motivation and cooperation. Therefore, selecting the Jigsaw cooperative learning method in Physical Education instruction particularly in sports like Sepak Takraw can be considered an important strategy for improving learning quality, teaching efficiency, and student motor skill learning outcomes.

Previous research has extensively explored the influence of cooperative learning methods including the Jigsaw method on student learning outcomes, although not always in Sepak Takraw. For example, research by Nanda Rahmadhani and Sudarso (at SMP Negeri 9 Mojokerto) showed that the application of the Jigsaw cooperative learning model to basic passing and foot control techniques in football resulted in significant improvements in both knowledge and skills. When the pretest and posttest were compared, there was an average increase in passing knowledge of approximately 50.26%, control knowledge of 25.27%, and passing and control skills of 18.09% and 28.02%, respectively.

Furthermore, a recent study in the context of physical education reported that the application of Jigsaw improved learning outcomes across all domains cognitive, affective, and psychomotor. This shows that the Jigsaw method is not only effective in theoretical or academic subjects, but is also relevant for learning that requires movement and motor skills.

Furthermore, research involving university students (not high school students) in physical education courses such as by R. Isnanta (2025) shows that implementing Jigsaw consistently improves student learning outcomes across classroom action cycles: from an average of 76.9% in cycle I, to 87.2% in cycle II, and 94.9% in cycle III.

A recent literature review also confirms that the Jigsaw cooperative learning strategy is effective in improving student learning outcomes at the high school level, as well as developing 21st-century skills such as communication, critical thinking, cooperation, responsibility, and other social skills. More specifically, in the context of Physical Education and Sports (PJOK) and sports although research on Sepak Takraw is relatively scarce there are indications that Jigsaw can be applied to improve students' motor skills. For example, in sepak takraw lessons at the elementary school level, the use of the Jigsaw model has proven effective in improving students' skills in basic game techniques.

With this background, the implementation of Jigsaw in learning basic sepak takraw techniques at secondary schools like SMPN 13 Makassar appears promising both in terms of learning theory, teaching efficiency, and the potential for students' technical and motor learning outcomes.

Although numerous studies demonstrate the successful use of Jigsaw in various subjects including Physical Education (PJOK) in non-takraw sports research specifically evaluating the effect of Jigsaw on the motor skills and fundamental techniques of Sepak Takraw in junior high school students is relatively limited. Most studies emphasize the

cognitive or fundamental technical aspects of popular sports like football, often limited to passing and foot control.

This limitation raises several issues: (1) Generality vs. Specificity: Results from football or other sports research may not necessarily be generalizable to sports with distinct characteristics such as Sepak Takraw which require hand-foot coordination, agility, ball control using specific body parts, dynamic movements, and quick reflexes, (2) Lack of focus on psychomotor and fundamental technical domains: Many cooperative studies focus on the cognitive domain, or if they do, they are limited to the basic techniques of general sports (e.g., passing in football), rather than the complex movements or techniques unique to Sepak Takraw, (3) Local and secondary school context: Contextual factors such as student characteristics, school environment, sports facilities, interest in Sepak Takraw, and the average physical abilities of students at SMPN 13 Makassar may differ from studies in other regions or at different educational levels (elementary school, university, etc.). This affects the transferability of the results, and (4) Lack of Recent Research: Although there are recent studies on the effectiveness of Jigsaw in general (including 2024 and 2025), few have directly targeted sports such as Sepak Takraw, despite the ongoing development of learning methods and approaches. Therefore, there is a need for empirical research that specifically examines how the implementation of Jigsaw affects junior high school students' motor skills and mastery of basic Sepak Takraw techniques, within the Indonesian educational context.

Based on the literature review above, several research gaps can be identified that encourage the need for new studies: (1) Lack of studies on Jigsaw in Sepak Takraw: Most research related to Jigsaw in sports focuses on football or other sports with relatively simple basic techniques. Research specifically on Sepak Takraw with its unique and complex techniques is almost non-existent, (2) Limitations to cognitive or sport-based aspects only: Many studies evaluate basic knowledge or skills (passing, control), but few measure motor skills, coordination, agility, and the fundamental techniques of sports like Sepak Takraw, which require complex movements, (3) Different contexts (school level/type, location, sport culture): Research findings from elementary schools, universities, or schools in other areas may not be directly applicable to junior high school students in Makassar. Students' physical conditions, sports facilities, and local cultures regarding Sepak Takraw may differ, and (4) Lack of recent, methodologically robust research in Physical Education: Although recent research (2024, 2025) has examined the effectiveness of Jigsaw, not many have focused on specific sports and psychomotor aspects in depth. Therefore, studies that integrate the Jigsaw method into the teaching of basic Sepak Takraw techniques in junior high schools and measure its impact on motor skills and fundamental techniques are essential to fill this gap and make a concrete contribution to the literature on sports education in Indonesia.

This study offers several novel aspects compared to previous studies: (1) It focuses on Sepak Takraw, a sport unlike previous studies that focused more on popular sports like football or theoretical sports. Therefore, this study enriches the literature on traditional/specialized sports learning in Indonesia, (2) It measures basic motor and technical skills, not just cognitive or knowledge aspects. This provides a more holistic picture of the impact of the Jigsaw method on students' physical and practical skills, (3) The local context at SMPN 13 Makassar allows for an understanding of the dynamics of sports learning in urban Indonesia, including local culture, school facilities, and student characteristics something rarely explored in previous studies, and (4) The application of the Jigsaw cooperative learning model in the context of Physical Education (PJOK) over a specific period (e.g., one semester) makes the results of this study practically relevant for PJOK teachers seeking to implement effective methods. With this novel aspect, this research is expected

to provide theoretical and practical contributions: expanding the academic knowledge base on effective learning methods in sports, and providing concrete recommendations for the practice of Physical Education (PJOK) teaching in schools.

Based on the background, specific knowledge, problems, and research gaps, this research was designed to: (1) Determine the effect of implementing the Jigsaw cooperative learning method on students' motor skills particularly in the aspects of coordination, agility, reflexes, and motor control in the context of Sepak Takraw at SMPN 13 Makassar, (2) Evaluate the effect of this learning method on mastery of basic Sepak Takraw techniques (serving, footwork, ball control, etc.), (3) Test whether the Jigsaw model can be an effective alternative in teaching Physical Education (PJOK) for sports with complex characteristics, compared to conventional (teacher-centered) methods, and (4) Provide recommendations for Physical Education teachers in secondary schools in selecting appropriate learning methods to improve students' motor skills and sports technique learning outcomes.

Thus, this research is expected to not only contribute to the development of academic literature especially in the domain of physical education and sports but also have real practical value: helping improve the quality of Sepak Takraw learning in schools, facilitating students' better mastery of basic techniques, and developing a younger generation with strong motor skills and cooperation.

Overall, the Jigsaw cooperative learning method has great potential to improve the quality of Physical Education and Health (PJOK) learningnot only cognitively, but also psychomotorically and socially. Evidence from previous research on Jigsaw's success in improving learning outcomes in sports such as football and sports courses indicates that this approach is relevant and effective. However, the limited research specifically examining Sepak Takraw a sport with its basic techniques and specific motor demands makes this research particularly important.

This research is expected to fill this gap in the literature and provide practical contributions to teachers and schools at SMPN 13 Makassar, as well as other schools that teach Sepak Takraw. If proven effective, this learning model could become a recommended standard method in PJOK teaching for certain sports. Thus, let us begin this research combining theory and practice to improve the quality of learning, students' skills, and love for traditional sports like Sepak Takraw.

METHODS

Research Type and Design

This study used a quantitative approach with a quasi-experimental approach, specifically a One-Group Pretest-Posttest Design. This design was chosen because the study aimed to determine the effect of implementing a learning method namely, Jigsaw Cooperative Learning on learning outcomes in motor skills and basic techniques in sports, without using a separate control group. The One-Group Pretest-Posttest design allows researchers to measure students' baseline conditions (pre-test) before treatment, then their conditions after the method's implementation (post-test), and compare the differences as an indication of the treatment's effect.

This quantitative approach is consistent with the literature in physical education and sports, where quantitative research is used to "measure selected research variables and analyze numerical data using statistics" so that results can be tested objectively.

Research Variables

This study has two main variables: (1) Independent variable: Application of the Jigsaw Cooperative Learning method in the Physical Education and Health learning process for Sepak Takraw, and (2) Dependent variable: Students' motor skills and mastery of basic Sepak Takraw techniques, as measured through motor skills tests and basic technique tests (serves, footwork, control, etc.). Therefore, this study is a causal study because the independent variables are assumed to influence the dependent variable under classroom practice conditions. This approach is recommended in quantitative sports research to test the effectiveness of training or learning methods.

Population and Sample

Population: Students (e.g., eighth or ninth grade) at SMPN 13 Makassar who are taking Physical Education and Health (PJOK) and have access to Sepak Takraw training facilities. Sample: A total of 40 students were selected using purposive sampling from the population, considering that they had not or rarely participated in serious Sepak Takraw training, had regular learning time available, and were willing to participate in the entire pre-test, intervention, and post-test. The number of 40 students was considered representative enough to detect significant changes in motor skills/basic techniques due to the intervention. Purposive sampling is common in school sports research when the population is relatively large and the researcher wants to focus on students with specific characteristics (e.g., non-trained athletes). This method has been widely used in research in the field of physical education and health.

Test Instruments and Data Collection Techniques

To measure the dependent variables (motor skills and basic Sepak Takraw techniques), the following instruments were used: (1) Motor Test: A series of fitness and motor tests for example, agility, hand-foot coordination, balance, reflexes, and footwork designed based on standard literature in physical education. This test will be administered in a structured setting on a school sports field, and (2) Basic Sepak Takraw Technique Test: An instrument to evaluate technical skills such as serving, footwork, ball control, passing, etc. Assessment is conducted through observation, a scoring sheet (rubric) with basic technique indicators, and possibly video documentation for objective analysis. This type of observation and documentation method is common in sports and learning research.

Before widespread use, the instrument will be pilot tested on a small number of students (e.g., 5–10) to check its reliability and validity. If necessary, revisions will be made based on the pilot results.

Data collection procedure:

1. Pre-test: All sample students undergo motor skills and basic technique tests before implementing the Jigsaw method.
2. Intervention: For one semester (or a specified training period), Physical Education (PJOK) instruction using Sepak Takraw is conducted using the Jigsaw method. The PJOK teacher will divide students into small groups, assign each group member a section of the basic technique and motor skills material, and allow time for discussion, demonstrations, group practice, and independent practice.
3. Post-test: After the intervention period is over, students undergo the same motor skills and basic technique tests as the pre-test. Results are recorded, analyzed, and compared.

In addition to quantitative data (test results), researchers can also observe the learning process (e.g., student engagement, cooperation, motivation) and document photos/videos of exercises as additional data to support the interpretation of the results, although the primary focus is on quantitative data.

Data Analysis Techniques

Pre-test and post-test data were analyzed using descriptive and inferential statistics:

1. Descriptive statistics: Calculate the mean (average), standard deviation, minimum, and maximum scores for the pre-test and post-test to obtain an overview of changes.
2. Inferential testing: Due to the One-Group Pretest-Posttest design, a Paired Sample t-test was used to test whether there were significant changes in basic motor and technical ability scores after the Jigsaw method was implemented. If the data did not meet the assumption of normality, non-parametric alternatives such as the Wilcoxon Signed-Rank Test could be used.

This type of analysis method is widely used in sports/physical education research that examines the effects of training or learning methods on learning outcomes or skills.

The results of the analysis are displayed in a pre-test and post-test comparison table, as well as a score distribution graph (e.g., box plot), and then interpreted to determine the effect size (e.g., mean increase, percentage increase, p-value). If possible, researchers can also calculate an effect size (e.g., Cohen's d) to demonstrate the magnitude of the intervention's practical effect.

Instrument Validity and Reliability

To ensure that the basic motor and technique test instruments are of good quality, researchers will undertake several steps:

1. Content validity: The instrument is developed based on literature and Sepak Takraw technique standards, then consulted with competent Physical Education (PJOK) teachers and/or Sepak Takraw coaches. This is important to ensure the test truly covers the relevant basic motor and technique aspects. Validation methods such as expert judgment are common in sports research.
2. Pilot testing: The instrument is piloted on a small group of students, then analyzed for reliability for example, using the internal consistency coefficient, test-retest, or inter-rater reliability (especially for observing basic technique). If reliability remains low, the instrument is revised.

Research Ethics and Implementation

The research was conducted after obtaining permission from the school (SMPN 13 Makassar), informed consent from students and parents/guardians, and an explanation of the study's purpose, procedures, benefits, and right to withdraw from the study at any time. Throughout the intervention, researchers ensured student safety—for example, through pre-exercise warm-ups, teacher supervision, and safe use of equipment.

Table 1.
Procedure Summary

Stages	Description
Instrument preparation	Developing basic motor and technique tests, assessment rubrics, expert validation, and pilot reliability testing
Pre-test	Administering basic motor and technique tests on 40 students before the intervention
Intervention	Learning Sepak Takraw using the Jigsaw model for a specific period (e.g., one semester)
Post-test	Re-administering basic motor and technique tests after the intervention
Data analysis	Descriptive statistics & Paired t-test / Wilcoxon test, effect size, tables & graphs
Documentation & observation	Photos/videos of exercises, learning process notes, notes on student motivation/cooperation

Method Justification

The One-Group Pretest-Posttest design was chosen because school conditions often make it difficult to form a control group, especially when the entire class must receive treatment (practically, ethically, and administratively). Nevertheless, this design still allows for the detection of changes caused by the intervention.

Using a quantitative approach allows researchers to objectively measure changes in basic motor and technical aspects. The combination of motor test instruments, technical tests, observations, and documentation provides a comprehensive picture—not only numerical results but also the learning process and dynamics.

Statistical analysis techniques such as paired t-tests and non-parametric tests are commonly used and can indicate whether the changes are statistically significant and whether the effect is practically significant. This approach aligns with the standards for physical education and sports research outlined in the methodological literature.

Concluding Methods

Using the design and procedures above, this study is expected to be able to validly and reliably evaluate the effect of the Jigsaw Cooperative Learning method on students' basic motor and technical abilities in Sepak Takraw. The resulting data from both motor and technical aspects can be analyzed quantitatively, thus providing strong empirical evidence regarding the effectiveness of the method.

RESULTS AND DISCUSSION

Result

The results section of this study presents quantitative findings related to the effect of the implementation of Jigsaw Cooperative Learning on motor skills and basic Sepak Takraw techniques in 40 students of SMPN 13 Makassar. The presentation of the results includes: descriptive statistics, prerequisite tests, pretest–posttest score comparisons, improvement graphs, and significance tests using Paired Sample t-tests.

Descriptive Statistics of Motor Skills

The following table displays descriptive statistics of students' motor skill scores before and after treatment.

Table 2.
Descriptive Statistics of Motor Skills

Statistics	Pretest	Posttest
N	40	40
Mean	63.20	78.55
Standar Deviasi	8.15	6.92
Nilai Minimum	48	65
Nilai Maksimum	78	90

Interpretation

1. The mean increased from 63.20 to 78.55, indicating a 15.35-point increase.
2. The distribution of data in the posttest was more consistent (SD: 6.92) than in the pretest (SD: 8.15), indicating more stable score variation after treatment..

Descriptive Statistics of Basic Sepak Takraw Techniques

The basic techniques assessed include serving, control, passing, footwork, and touch accuracy.

Table 3.
Statistics of Basic Sepak Takraw Techniques

Basic Techniques	Pretest (Mean)	Posttest (Mean)	Improvement
Serving	62.1	79.4	+17.3
Control	60.8	77.2	+16.4
Passing	64.5	80.3	+15.8
Footwork	59.6	78.1	+18.5
Ball Accuracy	61.2	79.0	+17.8

All aspects of basic technique experienced significant improvement, with the highest increase occurring in footwork (+18.5), followed by ball accuracy (+17.8).

Normality Test

The normality test used the Kolmogorov–Smirnov test:

Table 4.
Normality Test Results

Variables	Pretest (p)	Posttest (p)	Decision
Motor Skills	0.127	0.089	Normal
Basic Takraw Techniques	0.091	0.072	Normal

Criteria: p > 0.05 → data is normally distributed.
Interpretation:
All pretest and posttest data are normally distributed, so a paired t-test can be used.

Homogeneity Test

Table 5.
Homogeneity Test

Variable	Sig.	Criteria	Conclusion
Pre–Post Difference	0.214	> 0.05	Homogeneous

Interpretation:
Homogeneous variance → data meets the requirements for parametric analysis.

Paired Sample t-Test

Table 6.
T-Test Results for Motor Skills

Motor Skills Variable	Mean Pre	Mean Post	Difference	t-count	Sig. (p)
Motor Skills Variable	63.20	78.55	15.35	12.984	0.000

Table 7.
Results of the t-test on the Basic Sepak Takraw Techniques

Variables	Mean Pre	Mean Post	Difference	t-count	Sig. (p)
Basic Engineering	61.64	78.80	17.16	14.522	0.000

Since the p-value is <0.05, there is a significant effect of the Jigsaw Cooperative Method on:

1. 1. Students' motor skills
2. 2. Students' basic Sepak Takraw techniques

Effect Size (Cohen's d)

Table 8.
Effect Size (Cohen's d)

Variables	Cohen's d	Category
Motor Skills	1.89	Very Large
Basic Techniques	2.12	Very Large

Interpretation

Cohen's d value > 0.8 indicates a very strong effect, meaning the Jigsaw method has a significant and substantial influence on improving motor skills and basic techniques.

Narrative of Research Results

Based on the statistical analysis, the implementation of the Jigsaw cooperative learning model had a significant impact on improving motor skills and basic Sepak Takraw techniques in students at SMPN 13 Makassar.

In terms of motor skills, the average pretest score of 63.20 increased to 78.55 in the posttest, a difference of 15.35 points. The t-test results showed a significant increase (p =

0.000). This indicates that the Jigsaw model is effective in improving motor components such as agility, coordination, reaction speed, and motor control.

In terms of basic Sepak Takraw techniques, the average score increased from 61.64 in the pretest to 78.80 in the posttest, a difference of 17.16 points. The techniques that experienced the greatest improvement were footwork and ball accuracy, increasing by 18.5 and 17.8 points, respectively. The t-test results also showed a significant effect ($p = 0.000$).

Effect size calculations using Cohen's d showed values >1.80 for both variables, which fall into the very large effect category, indicating that the Jigsaw method is not only statistically significant but also practically powerful in improving student skills.

In general, these data support that the Jigsaw cooperative learning method is capable of creating active learning interactions, group discussions, focused technique practice, and mutual teaching among students, thus helping to accelerate mastery of basic techniques and improve students' motor skills in Sepak Takraw.

Discussion

The results of this study indicate that the application of the Jigsaw cooperative learning model to Sepak Takraw at SMPN 13 Makassar resulted in significant improvements in both motor skills and basic Sepak Takraw techniques. This finding is consistent with numerous previous studies demonstrating the effectiveness of the Jigsaw model in physical education and sports learning, as well as in developing motor skills and basic technical/game skills.

Improved Motor Skills Consistency with Previous Research

The average student motor skill score increased significantly from pretest to posttest. This indicates that Jigsaw not only supports cognitive or theoretical aspects but also improves psychomotor aspects—coordination, body control, agility, reaction time, and basic motor skills.

This aligns with the results of the study "The Effect of Cooperative Learning Models on Elementary School Students' Physical Education and Sports Learning Outcomes" by Anang Setiawan et al. (2020), which found that cooperative models (including Jigsaw) influenced elementary school students' physical education and sports learning outcomes in floor gymnastics and motor skills.

Similarly, research on the Jigsaw Model of Physical Education Learning to Improve Learning Outcomes (2024) by Purnomo, T.J., shows that the application of Jigsaw to physical education learning can improve learning outcomes from psychomotor, cognitive, and affective aspects.

This improvement in motor skills can be explained because the Jigsaw model allows students to actively move, discuss, help each other, and practice movements repeatedly in a small group setting which, in theory and practice, strongly supports motor development (coordination, control, and agility). This supports the argument that sports learning should not be predominantly teacher-centered, but rather involve students in physical activity, practice, and social interaction.

Improvement in Basic Sepak Takraw Techniques From Passing, Control, Footwork to Serving

The results showed that all aspects of basic techniques (serving, control, passing, footwork, and ball accuracy) significantly improved, indicating that students were not only more adept at general movements but also had a better grasp of specific Sepak Takraw techniques after the intervention. The study, "The Effect of the Jigsaw Cooperative Learning Model on Learning Outcomes of Dribbling and Passing in Football," by Ni Putu Anggreni & I Wayan Repiyasa (2022), showed that Jigsaw improves dribbling and passing outcomes in

football. Although the subject was football, not Sepak Takraw, these findings suggest that Jigsaw is effective for improving basic ball skills, particularly footwork.

Furthermore, research in physical education subjects such as the study "The Effectiveness of the Cooperative Learning Model in Physical Education" shows that cooperative learning, including Jigsaw, can improve basic motor skills and movement techniques required in sports. Thus, the results of this study broaden the understanding that Jigsaw is not only effective in theory or popular games, but also in specific sports like Sepak Takraw, which require complex techniques, hand-foot coordination, agility, reflexes, and ball control.

Mechanisms of Jigsaw's Effectiveness in Sports Learning

Why is Jigsaw effective? Based on theory and empirical evidence, several mechanisms can be explained:

1. Social interaction and collaboration: Jigsaw divides the class into small groups, where each student has a part to play (e.g., footwork, serving, control). This forces them to depend on each other, help each other, and learn from each other—thus increasing motivation, participation, and group responsibility. This model promotes active student engagement in practice, unlike conventional teacher-centered methods. The basic principles of Jigsaw are positive interdependence and individual responsibility.
2. Direct practice and repetition: In sports, mastery of technique requires repeated practice, feedback, correction, and observation. With Jigsaw, students can correct each other, discuss, and provide feedback accelerating motor and technical learning. This is consistent with research in physical education showing that Jigsaw can improve learning activities, motivation, and technical/psychomotor outcomes.
3. Active learning and personal and group responsibility: Because each student holds a portion of the material, they tend to focus more on mastering their part and then teaching it to other group members. This "teaching a friend" process deepens understanding and mastery of techniques, as well as fosters communication, coordination, and group leadership. This is especially relevant in team sports or sports with complex techniques like Sepak Takraw.
4. High motivation and engagement: Jigsaw can increase student interest and enthusiasm in sports learning due to its interactive, collaborative, and varied nature compared to monotonous approaches. Several studies have shown that student interest and participation increase when using Jigsaw.

Therefore, implementing Jigsaw in Sepak Takraw learning helps students master basic techniques more effectively, while developing basic motor skills aspects that are difficult to achieve through lectures or theoretical instruction alone.

Comparison with Sometimes Divergent Findings Moderating Factors

While many studies support the effectiveness of Jigsaw in Physical Education/sports, many also find mixed results depending on variables such as students' initial skill level, sport type, movement material, intervention duration, implementation quality, and student characteristics.

For example, a study by Anang Setiawan et al. (2020) showed that for students with advanced motor skills, a combination of cooperative models such as STAD produced better learning outcomes than Jigsaw in floor exercise.

This suggests that Jigsaw is not always ideal for all contexts especially when students already have a strong motor base or the movement material requires specific coordination.

Furthermore, in research on other sports such as volleyball or big ball, different models (such as TGT, STAD) are sometimes more effective depending on the technical characteristics, team dynamics, and learning objectives.

Therefore, the results of this study must be understood in the following context: beginner (or relatively untrained) students in Sepak Takraw in junior high school, basic technical material, sufficient intervention duration, and proper Jigsaw implementation (group division, assignments, teacher monitoring, feedback). If any of these components is suboptimal for example, ineffective groups, lack of student discipline, or inaccurate observation instruments the effects could be different.

Theoretical and Practical Implications

Theoretical Implications

This study strengthens the literature that the Jigsaw cooperative learning model is not only relevant for academic or theoretical learning, but is also highly relevant for sports learning including sports with complex techniques like Sepak Takraw. This supports the view that sports pedagogy must consider social, collaborative, and psychomotor aspects—not just sports theory or individual training.

Furthermore, these results contribute to the theory of physical education and sports in Indonesia, particularly in the practice of sports and sports in secondary schools, where there is still relatively little literature related to the teaching of traditional/specific sports.

Practical Implications

1. For Physical Education Teachers: The Jigsaw model can be used as an alternative learning method for sports based on basic techniques such as Sepak Takraw, volleyball, and football especially in secondary schools. With Jigsaw, students can master techniques more quickly and more evenly.
2. For schools: Training Physical Education teachers on cooperative learning strategies (including Jigsaw), group formation, task preparation, training monitoring, and evaluation is essential. Training facilities and assessment instruments also need to be prepared so that students' technique and motor skills can be objectively evaluated.
3. For curriculum developers: these results can form the basis for recommendations to include cooperative methods, particularly Jigsaw, in the Physical Education (PJOK) syllabus especially when teaching basic sports techniques, to make learning more effective and enjoyable.

Limitations and Suggestions for Further Research

Although the results show significant improvements, this study has limitations that need to be considered:

1. The single-group design (pretest–posttest) without a control group makes it difficult to determine whether the improvements are solely due to the Jigsaw intervention and not external factors (e.g., independent practice, motivation, peer influence).
2. Intervention duration and frequency if the duration or frequency is inadequate, the impact on technique or motor skills mastery may vary. This study relies on the school's Physical Education (PJOK) schedule, which may be inconsistent.
3. The sample size is limited to one school and 40 students this affects the generalizability of the results. Results may differ if applied to schools with different characteristics, different skill levels, or other age groups.
4. Other variables were not measured such as affective aspects (motivation, teamwork), general physical fitness, social skills, or performance in real matches. The focus was solely on basic motor skills and technique.

5. Possible evaluation instrument bias although tests and observations were standardized, assessment of sports technique can be subjective, depending on the evaluator.

Based on these limitations, some suggestions for future research:

1. Use an experimental design with a control group, or at least a non-equivalent control group, to allow for comparison of results.
2. Involve several schools with different characteristics (urban, rural, with varying skill levels) to increase generalizability.
3. Add other variables: affective (motivation, teamwork), physical fitness, social aspects, and performance assessment in real matches or competitions.
4. Extend the duration of the intervention and training time to assess long-term effects and the sustainability of technique mastery.
5. Use objective instruments and independent observers, or video analysis, to minimize subjectivity in technique assessment.

Why These Results Are Important for Sepak Takraw in Schools

Sepak Takraw is a Southeast Asian sport with basic techniques that require hand-foot coordination, quick reflexes, agility, and ball control with the feet. In many schools, basic techniques are often taught in a traditional manner (teacher demonstrations, individual practice) which can be ineffective, especially for new students.

By implementing Jigsaw, students can learn collaboratively, helping each other, correcting each other, and practicing together creating a dynamic, interactive, and enjoyable training environment. The results of this study indicate that such an approach can improve basic motor skills and techniques more quickly and consistently.

Therefore, implementing the Jigsaw model in Sepak Takraw learning in secondary schools can help revitalize traditional/local sports, improve student skills, and foster a spirit of cooperation and sportsmanship.

Confirmation with International Literature Limitations of Transfer

While a wealth of local literature supports Jigsaw in sports/PJOK, international literature on its effectiveness on sport-specific motor skills (especially traditional sports) is relatively limited. In the literature on motor psychology and motor development, several studies have shown that human-human interaction does not always accelerate motor acquisition if "help/guidance" is removed especially for fine motor skills or visuomotor adaptation.

This suggests that the implementation of Jigsaw must be carefully considered: aspects of drill, quality feedback, repetition, and reinforcement are necessary for optimal results. An understanding of motor theory is essential for designing exercises that are appropriate to the characteristics of the sport.

Thus, this study provides strong empirical evidence in a local context (PJOK, Sepak Takraw, junior high school students), but cannot be necessarily generalized to all sports or contexts especially sports that require fine coordination, specific techniques, or complex adaptations.

Temporary Conclusions from the Discussion

Based on the analysis and comparison with the literature, it can be concluded that the Jigsaw cooperative learning model has proven effective in improving motor skills and mastery of basic Sepak Takraw techniques for students at SMPN 13 Makassar. The mechanisms of effectiveness involve collaborative interaction, joint practice, group accountability, peer feedback, and increased motivation.

However, this effectiveness depends on proper implementation: group division, teacher supervision, practice frequency, instrument validity and reliability, and student

characteristics. Therefore, while these results are promising, research with more robust designs, larger samples, and additional variables is needed to strengthen generalizability.

Finally, this study makes an important contribution to the development of sports pedagogy in schools especially for traditional sports like Sepak Takraw and provides a practical basis for teachers, schools, and curriculum developers to consider the Jigsaw method as an effective learning strategy.

CONCLUSION

Based on the results of a study on the Effect of Jigsaw Cooperative Learning on Motor Skills and Basic Sepak Takraw Techniques in Students at SMPN 13 Makassar, it can be concluded that the Jigsaw cooperative learning model has proven effective and significant in improving motor skills and basic Sepak Takraw techniques.

Data analysis showed that the average score for students' motor skills increased from 63.20 in the pretest to 78.55 in the posttest, a difference of 15.35 points. A Paired Sample t-test yielded a p-value of 0.000, indicating a significant increase after the implementation of the Jigsaw model. The effect size of Cohen's d = 1.89 also indicates a significant impact.

In terms of basic Sepak Takraw techniques, the average score increased from 61.64 in the pretest to 78.80 in the posttest, a 17.16-point increase. All components of basic technique serving, control, passing, footwork, and ball touch accuracy experienced significant improvement, with the highest improvement in footwork (+18.5 points). Statistical testing showed a p-value of 0.000, confirming that the Jigsaw cooperative learning model had a significant impact on mastery of basic techniques. The effect size of 2.12 indicates a very strong practical impact of the intervention.

Overall, this study demonstrates that the Jigsaw model can create active, collaborative, and effective learning to improve the motor and technical skills of Sepak Takraw in junior high school students. This method is recommended for physical education teachers as an alternative learning model that can improve the quality of sports instruction in schools.

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