The Combination of Deep Learning and TGT Learning Models to Improve Learning Outcomes and Tennis Groundstroke Technique Skills

Wasis Himawanto[1]✉, Haryo Mukti Widodo[2], Puspodari[3]
(1) Master of Sports Teaching, Universitas Nusantara PGRI Kediri, Indonesia
(2) Sports Education Study Program, STKIP PGRI Bangkalan, Indonesia
(3) Master of Sports Teaching, Universitas Nusantara PGRI Kediri, Indonesia

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✉ Corresponding author
(himasis_23@unpkediri.ac.id)
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Abstract

Groundstroke is a fundamental tennis skill that requires both conceptual understanding and accurate technical execution; however, many Physical Education (PE) students experience difficulties in mastering these aspects through conventional instructional approaches. This study aimed to examine the effect of integrating the Deep Learning pedagogical approach and the Team Games Tournament (TGT) model on students' learning outcomes and groundstroke technical skills in tennis education. A quasi-experimental posttest-only control group design was employed involving 80 PE students divided into experimental and control groups. Data were collected using a cognitive learning achievement test and a groundstroke performance assessment rubric. Descriptive statistics and the Mann–Whitney U test were used for data analysis. The results showed that the experimental group achieved higher scores than the control group in both learning outcomes and technical performance. The experimental group obtained a mean learning outcome score of 91.70 ± 6.49 compared with 65.20 ± 8.46 in the control group, while groundstroke technical performance scores were 27.60 ± 2.89 and 16.25 ± 1.21, respectively. The Mann–Whitney U test indicated significant differences between groups for learning outcomes ($p < 0.001$) and groundstroke technical skills ($p < 0.001$). These findings demonstrate that integrating meaningful learning processes with cooperative and competitive activities through Deep Learning and TGT can provide an effective instructional strategy for improving cognitive understanding and technical performance in tennis education.

Keyword: *Deep Learning; Team Games Tournament; Cooperative Learning; Groundstroke; Physical Education.*

1. INTRODUCTION

Sports play a vital role in the education framework, not merely enhancing physical health but also fostering character, self-discipline, and teamwork during the learning journey. The role of sports in education is crucial for molding the social and emotional values in students, which persist in community interactions (Bisa, 2023). Focusing on physical education, tennis stands out as a sport rich in educational significance, as it requires a blend of physicality, technical skill, strategic thinking, and mental fortitude. The method of teaching adopted is critical in developing both technical proficiency and comprehension of the sport (Mulyana et al., 2025). Students in physical education are expected to acquire foundational tennis skills, particularly groundstrokes, to thoroughly grasp game strategies. This aligns with findings indicating that the methodology employed greatly impacts the improvement of both forehand and backhand groundstroke abilities in tennis (Budi et al., 2020). Additionally, proficiency in groundstroke techniques is a vital factor in an athlete's performance since these skills rely on both technical prowess and physical fitness (Nugroho et al., 2022). Nevertheless, many students continue to face challenges in properly mastering these fundamental techniques, leading to poor results in both skill development and overall athletic performance.

The tennis instruction at many colleges and universities frequently follows a traditional method centered around direct teaching from educators to learners, which leads to passive involvement where students merely copy movements without thoroughly understanding biomechanical aspects and game strategies. Evidence indicates that the teaching practices in physical education often contradict the aim of enhancing students' social and personal capabilities, requiring them to be obedient, disciplined, and simply absorb the information delivered (Jin, 2013). This environment hampers students' ability to grasp skills both conceptually and practically. Supporting this, research highlights that conventional teaching models in physical education lead to minimal student involvement, as they receive explanations and demonstrations from teachers without active engagement (C. Wang et al., 2023). As a result, advancements in technical skills like forehand and backhand groundstrokes are typically slow, with students struggling to forge meaningful links between theory, observation, and hands-on practice. Similar findings emerged from other studies confirming that instructor-led teaching methods contribute to diminished student participation, with learners mostly listening and mimicking without fully understanding movement principles (X. Wang & Cao, 2021). Furthermore, a rigid and controlling teaching approach detrimentally affects student motivation and involvement in the learning of sports, as research indicates that teaching style greatly influences learning results, psychological needs, and student engagement in physical education activities (Coterón et al., 2024).

To tackle these challenges, it is necessary to create new learning models that actively involve students and promote a substantial understanding of concepts. In this research, Deep Learning is defined as an educational method that prioritizes significant, thoughtful, and contextual learning experiences where learners actively build knowledge, connect new information with previous experiences, and cultivate advanced thinking skills (Marton & Säljö, 1976; Biggs, 1999). This interpretation is distinct from the deep learning concept utilized in artificial intelligence, which pertains to computational techniques based on neural networks; hence, this investigation centers on the educational aspect of Deep Learning.

Recent studies indicate that physical education frameworks that focus on active engagement, creativity, and worthwhile learning encounters can significantly enhance students' physical fitness, cognitive skills, and decision-making abilities (Mavilidi et al., 2018). Combining these methods with cooperative learning strategies is deemed pertinent as physical education necessitates not only motor skill development but also the improvement of social interactions, problem-solving capabilities, and teamwork. One cooperative learning framework that is consistent with these values is the Team Games Tournament (TGT) strategy, which prioritizes collaboration, competition, and active participation by students. Prior research has shown that TGT can boost students' motivation, involvement, and social interactions during physical education lessons (Usra et al., 2023).

Consequently, merging the Deep Learning pedagogical framework with the Team Games Tournament (TGT) model offers a valuable approach to enhancing physical education instruction. The integration of meaningful learning experiences and competitive collaborative activities may motivate students to engage more profoundly in their learning, develop critical thinking abilities, and assist in advancing both physical and cognitive skills in sports education.

The deep learning pedagogical framework prioritizes the creation of significant and thorough comprehension through reflection, assessment, idea integration, and active involvement, rather than relying solely on memorization or mechanical practice. Within educational settings, deep learning motivates students to grasp concepts, utilize advanced cognitive skills, link new information with existing knowledge, and take an engaged position in their learning journeys (Ikhsan & Setiawan, 2025). This strategy is particularly pertinent in physical education for acquiring sports skills, as proficient skill execution demands not only practice but also an insight into movement mechanics, coordination, strategy choices, and the intentions behind each technical movement. When applied to learning groundstrokes, this pedagogical deep learning method encourages learners to comprehend the rationale and technique behind specific movements, rather than just mimicking the shown skills. Consequently, students can actively reflect on their actions, recognize technical flaws, investigate the reasons for these mistakes, and find suitable methods to enhance their performance. This type of reflective and analytical approach can develop metacognitive awareness, allowing learners to oversee and adjust their own processes of learning and execution. This viewpoint aligns with research showing that instructional methods focused on deep learning can enhance critical thinking, foster student initiative, boost active participation, and lead to improved educational outcomes (Weng et al., 2023). Thus, in the realm of sports education, deep learning can be viewed as a teaching strategy that assists students in cultivating both technical skills and a well-rounded understanding of the concepts related to skilled performance.

At the same time, the Team Games Tournament (TGT) approach, a style of cooperative learning introduced by Slavin in 1995, highlights the importance of teamwork among participants through friendly competition. Studies indicate that learning through games designed with the TGT approach creates a more relaxed environment for students while promoting accountability, teamwork, healthy rivalry, and increased engagement in learning (Fitriasari, 2019). This approach offers students chances to learn through social exchanges, peer teaching, and enjoyable competition. Additional research indicates that using the TGT learning approach can boost students' motivation to learn and their active involvement, thanks to the group dynamics and tournament framework, which foster a positive competitive attitude (Hakim et al., 2025). TGT gives students chances to learn through social exchanges, mutual instruction, and enjoyable competitions. Moreover, findings from research conducted by (Nadrah, 2023) verify that the TGT model organizes students into teams with different skill levels to engage in equitable and enjoyable tournaments, leading to a more competitive yet collaborative learning environment compared to conventional instructional methods. The tournament structure inspires students to enhance both personal and team achievements, as their educational results contribute to the team's overall success. Specifically, in tennis learning, the TGT method enables students to practice fundamental techniques like groundstrokes within a competitive game that encourages sportsmanship and a shared sense of responsibility. This corresponds with studies indicating that TGT effectively promotes social interaction and teamwork in acquiring sports skills (Pranata & Syamsijulianto, 2025).

The blend of Deep Learning with TGT fosters a connection between theoretical knowledge and hands-on abilities. Studies indicate that employing deep learning methods in tennis coaching enhances learners' strategic analysis and movement techniques, allowing them to grasp the link between gameplay tactics and technical effectiveness (Zhang, 2024). Deep Learning contributes to enhancing students' cognitive abilities in grasping skills and game concepts, while TGT improves emotional and physical skills through joint competitive tasks. Recent reviews of studies have also demonstrated that learning collaboratively has a notable positive influence on outcomes in physical education, especially in enhancing students' physical, social, and cognitive skills (Boke et al., 2025). By merging these approaches, learners not only learn to properly perform groundstrokes but also understand the reasoning behind the effectiveness of these methods in particular game contexts. The combination of an analytical approach and cooperative learning has proven to develop self-awareness, decision-making abilities, and tactical insight within sports settings (Quan & Zhao, 2024). This unified strategy is anticipated to cultivate critical thinking, collaboration, and self-driven motivation for learning, which directly influences the enhancement of learning results and technical proficiency. Therefore, the partnership of deep learning techniques and collaborative frameworks like TGT not only maximizes cognitive elements but also establishes an engaging and competitive learning atmosphere (Weng et al., 2023).

While both models have shown effectiveness on their own in numerous educational studies, the combined use of Deep Learning and TGT in tennis education is still quite uncommon. Current studies indicate that deep learning methods enhance higher-order thinking skills, yet most of the research is confined to theoretical frameworks and hasn't been broadly utilized in the context of learning sports skills (Weng et al., 2023). Furthermore, much of this research emphasizes theoretical contexts or general learning strategies, with minimal focus on practical applications in sports skills learning, which necessitate coordination of movements and awareness of actions. This point is underscored by research findings (J. Chen & Singh, 2024) indicating that even though the term deep learning is now commonly referenced in education, its framework and practical applications, especially in physical education, remain limited and not well standardized. In contrast, extensive research has been performed on cooperative learning models, especially the TGT model, which has been shown to effectively enhance student motivation, teamwork, and cognitive results (Nofriansyah et al., 2025). Nonetheless, many of these studies have not incorporated a deep learning approach focusing on analysis, reflection, and understanding movement concepts. This indicates a research gap that needs to be addressed to explore how the combination of Deep Learning and TGT could effectively enhance student learning results and tennis skills.

This research seeks to fill an existing void in the literature by introducing a comprehensive model that merges Deep Learning principles with the Team Games Tournament (TGT) framework specifically for groundstroke techniques in tennis education. In this research, Deep Learning embodies an educational approach that prioritizes significant comprehension, reflective thought, exploration of concepts, and the capacity of students to assess their own learning journey. The instructional activities planned focus on exploring biomechanical concepts, structured skill drills, reflective assessments, and tournament-related tasks that promote collaboration and active involvement.

Prior research has investigated innovative methods in the realm of tennis education, particularly centered on devising strategies that enhance groundstroke efficiency ((Rusdiyanto et al., 2025). Nonetheless, these investigations have largely concentrated on refining technical skills and the learning process, often overlooking the incorporation of a collaborative competitive framework that systematically nurtures students' abilities in self-reflection, teamwork, and decision-making. Similarly, studies into the TGT model have highlighted its success in boosting motivation, engagement, and educational outcomes in physical education and sports competencies (Usra et al., 2023). However, these applications have predominantly focused on cooperative competition, sidestepping the integration of a profound, reflective learning framework aimed at grasping movement concepts.

Consequently, this study's originality stems from the synthesis of Deep Learning methodologies with the TGT model, creating a cohesive instructional approach tailored to tennis groundstroke learning. Unlike prior research that has explored these frameworks independently, this investigation delves into how significant conceptual comprehension, awareness of biomechanics, self-reflection, teamwork, and competitive learning settings can collectively enhance students' technical execution and educational results. This integrated model aims to offer a more holistic strategy for tennis instruction by connecting cognitive insight, development of motor skills, and social engagement within the context of physical education.

This study aims to make a theoretical contribution to the creation of sports education learning models by highlighting the importance of blending deep cognitive and cooperative-competitive methods to enhance psychomotor learning results. For instance, research regarding cooperative learning in physical education revealed that implementing collaborative learning models greatly improved students' motor abilities and social interactions (Bores-García et al., 2021). Additionally, in the area of technology and active learning, findings indicate that using deep learning strategies within physical education settings allows for better comprehension of movement principles and movement analysis capabilities among students (Ji et al., 2025). On a practical level, the findings from this research are anticipated to provide a guide for educators and trainers in crafting more effective, engaging tennis teaching methods focused on gaining a deeper understanding and practical skills in the sport. Furthermore, this study may support a new approach in physical education that emphasizes not only physical ability but also concept mastery, self-reflection, and social interaction.

The main objective of this study is to investigate the impact of combining the Deep Learning framework with Team Games Tournament learning strategies on cognitive learning results and technical proficiency in tennis groundstrokes among students in Physical Education. More specifically, this study has two aims: (1) to assess how effectively the combined learning model enhances students' cognitive learning achievements, and (2) to examine its influence on students' technical capabilities in executing tennis groundstrokes.

2. METHODS

This research utilized a quasi-experimental design focusing on posttesting with a control group to explore the impact of merging the Deep Learning teaching method with the Team Games Tournament (TGT) model on students' cognitive learning results and technical skills in executing tennis groundstrokes. Participants were grouped into two segments: an experimental group that received the combined Deep Learning-TGT intervention and a control group that received traditional tennis instruction. This particular design was chosen as it facilitates a comparison of the learning outcomes and technical abilities of both groups after applying differing teaching methods.

The research took place on a tennis court that was designated for practical activities within the Physical Education, Sports, and Health curriculum. The sample consisted of 84 students from two intact Physical Education classes. From this group, 80 students who fulfilled the specified inclusion criteria were selected for the study. These criteria included consistent attendance, no injuries or health issues that could affect tennis performance, and a willingness to participate throughout the intervention phase. The two intact classes were randomly assigned to either the experimental group or the control group, with one receiving the integrated Deep Learning and Team Games Tournament intervention while the other followed the traditional learning method. Each group comprised 40 students. Prior to the intervention, the baseline characteristics of both groups were analyzed to ensure their comparability. The intervention lasted for eight weeks and consisted of 16 learning sessions, which were followed by a posttest evaluation of cognitive learning outcomes and technical skills in tennis groundstrokes.

The experimental group engaged in tennis learning activities that combined Deep Learning concepts with the TGT approach. The learning process unfolded in six distinct stages: Meaningful Learning, Mindful Learning, Team Study, Games, Tournament, and Reflection. The Meaningful Learning phase focused on developing a conceptual understanding of groundstroke techniques, including the principles of movement and biomechanical concepts. The Mindful Learning phase motivated students to scrutinize their execution of movements and pinpoint technical mistakes. In the Team Study phase, students participated in group discussions, observed peers, and provided feedback to one another. The Games and Tournament phases allowed students to practice their groundstroke techniques through a series of organized activities, such as Target Groundstroke, Consistency Rally, Accuracy Challenge, Forehand Challenge, Backhand Challenge, and Mini Match. The Reflection phase encouraged self-assessment and peer assessment, prompting students to analyze their performance and recognize areas needing improvement.

Table 1. Learning Stages and Activities of the Integrated Deep Learning–TGT Model

Learning Stage	Activity	Technical Aspect Assessed
Meaningful Learning	Video observation and demonstration	Ready position, backswing, impact
Mindful Learning	Technical error analysis	Grip, footwork, impact
Team Study	Collaborative practice and peer feedback	Grip, footwork, backswing, follow through
Games	Target and rally activities	Accuracy and consistency
Tournament	Competitive application	Technical execution and decision making
Reflection	Self and peer evaluation	Overall technical improvement

The control group was provided with traditional tennis teaching methods, which included teacher-led demonstrations, verbal explanations, and standard skill drills without the incorporation of Deep Learning and Team Games Tournament (TGT) strategies. The materials, instructor, amount of contact time, and practice duration remained the same as those provided to the experimental group. The lessons for the control group adhered to a typical instructional sequence comprising explanation, demonstration, guided practice, skill drills, and feedback from the instructor. Consequently, the primary distinction between the two groups lay in the instructional method employed, as the experimental group received the combined Deep Learning and TGT framework while the control group followed conventional tennis teaching.

To assess the research outcomes, two measurement tools were utilized: a cognitive learning achievement examination and a structured rubric for evaluating tennis groundstroke performance. The cognitive test focused on students' comprehension of forehand and backhand groundstrokes, phases of movement, biomechanical concepts, tactical uses, analysis of technical errors, and decision-making in competitive situations. The performance rubric evaluated the execution of forehands and backhands based on factors like readiness position, grip, footwork, backswing, impact, follow-through, accuracy, and consistency. Both assessment tools were evaluated by experts in physical education and tennis coaching to confirm the appropriateness and clarity of the criteria for evaluation. The assessments were conducted following standardized procedures to ensure uniform evaluation across both the experimental and control groups.

Table 2. Indicators of Groundstroke Learning Outcomes

Learning Indicator	Assessment Method
Understanding forehand and backhand concepts	Cognitive test
Understanding movement phases	Cognitive test
Understanding biomechanics	Cognitive test
Tactical application of groundstroke	Cognitive test
Analysis of technical errors	Cognitive test
Decision making in game situations	Cognitive test

Data were examined through quantitative methods utilizing IBM SPSS software. Descriptive statistics were computed to assess the average and standard deviation for each variable. The Shapiro-Wilk test was employed to evaluate the normality of the data. The findings demonstrated that the data did not follow a normal distribution ($p < 0.05$), prompting the use of the Mann-

Whitney U test to explore the differences between the experimental group and the control group. All statistical evaluations were conducted at a significance threshold of α = 0.05.

Table 3. Groundstroke Technical Skill Observation Rubric

Component	Indicator	Score 1	Score 2	Score 3	Score 4
Ready Position	Ready Stance	Very Poor	Poor	Good	Very Good
Grip	Racket Grip	Incorrect	Less Appropriate	Appropriate	Excellent
Footwork	Foot Movement	Poor	Fair	Good	Very Good
Backswing	Initial Swing	Poor	Fair	Good	Very Good
Impact	Ball Contact	Poor	Fair	Good	Very Good
Follow Through	Follow Through Movement	Poor	Fair	Good	Very Good
Accuracy	Target Accuracy	Poor	Fair	Good	Very Good
Consistency	Repeated Successful Strokes	Poor	Fair	Good	Very Good

Ethical factors were incorporated at every stage of the research. Because this study was a component of standard educational activities and did not include invasive methods or interventions that exceeded typical physical education instruction, formal ethical approval was not required. However, before taking part in the study, every student was provided with information regarding the aims, methods, and voluntary aspects of their involvement. Written informed consent was secured prior to the gathering of data, and participants were made aware of their right to exit the study at any time without facing any repercussions. All gathered data were treated as confidential, and the identities of participants were safeguarded throughout both the research and reporting phases.

3. RESULTS AND DISCUSSION

3.1. Results

The effectiveness of the integrated Deep Learning and Team Games Tournament (TGT) model was evaluated based on two outcome variables: students' cognitive learning outcomes and tennis groundstroke technical performance. The descriptive analysis revealed that students who participated in the Deep Learning–TGT intervention achieved higher scores than those who received conventional instruction.

As presented in Table 1, the experimental group obtained a higher mean score for learning outcomes (ExLO = 91.70 ± 6.49) compared with the control group (CLO = 65.20 ± 8.46). A similar pattern was found for groundstroke technical performance, where the experimental group achieved a higher mean score (ETS = 27.60 ± 2.89) than the control group (CTS = 16.25 ± 1.21).

These findings indicate that students receiving the integrated Deep Learning–TGT model demonstrated better cognitive achievement and technical execution in tennis groundstroke skills compared with students receiving conventional learning.

Table 4. Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
ExLO	40	80	100	91.70	6.493
CLO	40	52	80	65.20	8.459
ETS	40	23	32	27.60	2.889
CTS	40	15	20	16.25	1.214

Information: ExLO (Experiment Learning Outcome), CLO (Control Learning Outcome), ETS

(Experiment Technique Skill), CTS (Control Technique Skill)

The Shapiro–Wilk test was conducted to examine the distribution of the data. The results indicated that all variables had significance values below 0.05, indicating that the data were not normally distributed.

Table 5. Normality

	Shapiro-Wilk		
	Statistic	df	Sig.
ExLO	0.902	40	0.002
CLO	0.909	40	0.004
ETS	0.925	40	0.011
CTS	0.851	40	0.000

Because the data did not meet the assumption of normality, the Mann–Whitney U test was conducted to examine differences between groups.

Table 6. Mann-Whitney U

	Learning Outcome	Teknik Groundstroke
Mann-Whitney U	4.000	0.000
Wilcoxon W	824.000	820.000
Z	-7.695	-7.751
Asymp. Sig. (2-tailed)	<0.001	<0.001
Effect size (r)	0.86	0.87
Effect-size interpretation	Large	Large

As shown in Table 6, the Mann–Whitney U test revealed statistically significant differences between the experimental and control groups in both learning outcomes and groundstroke technical performance (both $p < 0.001$). Because the outcome distributions were non-normal, the results should be reported using the median and interquartile range (IQR) in addition to, or instead of, the mean and standard deviation. The effect-size estimates were large for both learning outcomes ($r = 0.86$) and groundstroke technical performance ($r = 0.87$), indicating substantial differences between the experimental and control groups. These findings suggest that the integrated Deep Learning–TGT model was associated with markedly better learning outcomes and groundstroke technical performance than conventional instruction.

3.2. Discussion

The results from this research show that the group that underwent the experimental treatment scored better on the posttest compared to the control group in both technical performance of tennis groundstrokes and learning outcomes. Specifically, the experimental group reached a higher average score in technical skill for groundstrokes ETS = 27.60 than their counterparts in the control group CTS = 16.25. A similar trend was noticed in terms of learning outcomes, where the experimental group achieved a higher posttest score ExLO = 91.70 compared to the control group CLO = 65.20. These results imply that students who engaged in the integrated Deep Learning–TGT model displayed superior posttest performance regarding their grasp of tennis concepts and the execution of groundstroke skills relative to those who experienced traditional teaching methods. However, it is important to note that the study utilized a posttest-only framework with existing classes, and therefore, the initial equivalence of the groups was not firmly established. Consequently, the differences observed between the groups should be viewed as variations in posttest performance instead of conclusive proof of improvement or a causal impact attributable to the integrated learning model.

The magnitude of these differences suggests that the combination of Deep Learning and TGT provides complementary learning experiences that are not fully achieved through conventional instruction. The Deep Learning approach encourages students to understand the underlying principles of movement, including the relationship between body position, swing mechanics, timing, and ball control during forehand and backhand groundstrokes. Through conceptual exploration, reflection, and self-evaluation, students are encouraged to analyze movement errors and develop strategies for improvement. This process may explain why students in the experimental group demonstrated greater technical development, as their learning was based not only on repeated practice but also on a deeper understanding of why and how specific movements should be performed.

These findings support previous research emphasizing that meaningful learning approaches can enhance students' conceptual understanding, active engagement, and higher-order thinking skills (Angga & Sari, 2025 ; Nurdiana et al., 2024). However, unlike previous studies that primarily examined the effect of deep learning-oriented strategies on cognitive engagement, the present study extends this understanding by demonstrating its application in a psychomotor domain, specifically tennis groundstroke performance. The results suggest that meaningful learning principles can be effectively transferred into sports skill acquisition when students are provided opportunities to connect theoretical knowledge with practical movement execution.

The effectiveness of the integrated model can also be explained through the contribution of the TGT approach. The tournament-based structure created a competitive yet collaborative learning environment in which students actively practiced, received peer feedback, and developed responsibility toward individual and team performance. Previous studies have reported that TGT can improve motivation, participation, and learning achievement in physical education settings (Usra et al., 2023 ; Damayanti et al., 2025). In the current study, the role of TGT was not limited to increasing student motivation but also functioned as a mechanism for applying and reinforcing the knowledge acquired through the Deep Learning process. Students were required to make tactical decisions, adapt their techniques during games, and evaluate performance outcomes within competitive situations.

The improvement in groundstroke technical ability further highlights the importance of integrating cognitive and social learning components into tennis instruction. Groundstroke performance requires the coordination of several physical and technical factors, including grip control, body positioning, agility, timing, and hand-eye coordination (Hardaning et al., 2025). The present findings indicate that these components may develop more effectively when students are engaged in reflective practice combined with collaborative competition. Rather than performing repetitive drills without contextual understanding, students in the experimental group were encouraged to identify movement problems, discuss solutions with peers, and apply technical concepts during game-based activities.

The findings also contribute to previous research on TGT implementation in sports education. While earlier studies have demonstrated positive effects of TGT on participation and basic skill development in various sports contexts (Usra et al., 2023) , this study provides additional evidence that TGT can be strengthened when combined with a reflective learning framework. The novelty of this approach lies in integrating cognitive understanding, technical practice, and social interaction into a single instructional model. Therefore, the success of the intervention may be attributed to the interaction between Deep Learning principles, which enhance understanding and reflection, and TGT mechanisms, which increase motivation, cooperation, and active skill application.

From a practical perspective, these results suggest that physical education teachers and tennis instructors should consider instructional models that balance cognitive engagement with motor practice. Effective sports learning should not only aim to produce technically competent students but also develop learners who can analyze movement, make informed decisions, and independently evaluate their performance. The integration of Deep Learning and TGT provides an alternative approach for creating more meaningful, student-centered, and skill-oriented tennis learning environments.

4. LIMITATIONS

Despite the significant findings, this study has several limitations that should be considered. First, the research employed a posttest-only design, which limits the ability to determine the extent of improvement from students' initial performance levels. Future studies should incorporate pretest-posttest measurements to provide stronger evidence regarding learning progression. Second, the participants were recruited from a single institution using intact classes, which may restrict the generalizability of the findings to broader populations with different educational backgrounds and learning environments. Third, the researchers were involved in the instructional process and assessment procedures, which may introduce potential observer or researcher bias. Future research should consider involving independent assessors or blinded evaluation procedures. Fourth, the intervention period was relatively short, making it difficult to determine whether the observed improvements can be maintained over a longer period. Finally, this study did not include follow-up assessments to examine skill retention and the long-term impact of the integrated Deep Learning and TGT model. Future investigations should include delayed posttests to evaluate the sustainability of learning outcomes.

5. CONCLUSION

Based on the results of the research, it can be inferred that the combination of the Deep Learning method and the Team Games Tournament (TGT) framework has a notable impact on students' learning results and technical abilities related to tennis groundstrokes. Merging these strategies creates an organized educational setting conducive to enhancing students' comprehension and practice of tennis groundstroke techniques. The Deep Learning method promotes a deep understanding of the techniques and tactics related to groundstroke execution, while the TGT framework offers structured opportunities for practice and learning activities. The results indicate that the fusion of Deep Learning and TGT leads to enhanced learning results and technical proficiency in tennis groundstrokes. Hence, this blend can be regarded as an effective educational strategy for fostering the advancement of students' learning achievements and technical proficiencies within tennis education.

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