

# Cognitive Development and Decision Making: Developing Tactical Decision-Making Skills in Basketball Through Game-Based Learning Approaches

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**Abstract:** *Tactical decision-making is the critical component to the basketball performance. Players need to be able to recognize the evolving situation and make decisions even in environments where there is limited time and space. Traditional game-based learning of instruction has not been very successful in developing these mental and tactical skills, so a new focus has been placed on game-based learning. This study examines the extent to which game-based training leads to improvements in tactical decisions and it is observational in nature. Drawing on current instructional theory, the review collates evidence that game centered approaches (including Teaching Games for Understanding, the Tactical Games Model and smaller sided games) contribute to tactical awareness, the choice of decisions and the execution of skills. Across the literature, there are consistent findings of game-based learning results in increases in cognitive engagement, intrinsic motivations and tactical paces. Yet there are still some gaps, far too few studies are specific to basketball and longitudinal outcome data is not available. In order to fill these gaps, a quantitative quasi-experimental study is proposed in which tactical decision making of players will be evaluated before and after a structured game-based program. Game performance was measured by using validated assessment tools that provided sport scientists, coaches, physical education instructors, etc. actionable data to enhance tactical development in basketball. The results showed that significant increase in the tactical decision-making ( $F = 191.738, p < .001$ ) and game-based learning ( $F = 214.874, p < .001$ ). However, game-based learning and tactical decision-making had a weak and insignificant correlation ( $r = -0.135, p = 0.180$ ). The game-based learning is a method of improving the performance of tactical decision making in basketball. The results recommend that the combination of tactical and learner-centered pedagogical models with sustainable basketball education and training programs are quite essential and impactful.*

**Keywords:** Cognitive Development; Decision Making; Basketball; Game-Based Learning Approaches SDG4

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## 1. Introduction

Basketball is a high velocity invasion sport that requires constant interplay between perceptual, cognitive and motor processes (Waffak et al., 2022). Players have to read developing situations during the course of play, have to anticipate the intentions of their opponents, and are thereafter required to be able to implement appropriate tactical reactions within the strict temporal and spatial constraints. Consequently, success on the court of basketball is not exclusively

dependent on an athlete's technical skill, it is predominately based on the ability of an athlete to make efficacious tactical decisions in dynamic environments. In recent years, tactical decision-making has become a key feature in sport pedagogy, and this expansion in the scope of tactical decision-making is a reflection of an educational shift favoring the conceptualization of performance as an integrated process (including the mediating processes of cognition, perception, and action) rather than simple technical action.

Traditional teaching methods in basketball have historically been characterized by skills drilling and prescriptive coaching protocols. Although such approaches can promote the development of isolated technical competencies, the degree to which these approaches promote the development of decisional acuity and tactical comprehension has been called into a great deal of scrutiny. Drill based instructional environments often do not approximate the intrinsic complexity and unpredictability of authentic competition, and so limit the ability of the learner to generalize acquired skills to live sport (Nopembri et al., 2022). Consequently, researchers and practitioners alike have been trying to discern alternative pedagogical paradigms well-suited to the proper alignment of training tasks and the exigencies of competitive play.

Game-based forms of learning have become a powerful response to such limitations. Such ways make learning an integral part of play and adapt games and problem-solving contexts calculated to real-world situations. Rather than competing technical skills with tactical comprehension skills, game-based learning embeds skills learning in a meaningful tactical context. This type of pedagogical shift is sought to improve the tactical awareness, decision-making accuracy and adaptability of players, without harming their high levels of engagement and motivation. There is a growing body of empirical evidence to support the effectiveness of game-based learning on the development of cognitive and performance related outcomes in Basketball and other invasion sports (Rusmana et al., 2023; Wang et al., 2024).

Recent research from Manninen et al. (2025) emphasis that choice furnishings in basketball are most well-developed through topic to the representative learning environments that have preserved key constraint of data informational elements of the competition (Manninen et al. 2025). Game-based learning harmonizes with this view as players are encouraged to actively examine tactical options, recognize affordances and change behavior in response to environmental stimuli. Studies have shown that the players who trained with tactical games and with small-sided games were able to make better decisions and execute skills compared to those players who trained with the traditional instruction (Rusmana et al., 2023; Perdima et al., 2024).

The increasing interest within the game-based learning research field is also represented in published systematic reviews and meta-analyses from the last years. These syntheses suggest positive consistent effects of game-based on decision-making, tactical knowledge and motor skill development across sports and educational levels (Gonzalez-Valero et al., 2024; Manninen et al., 2025). Such findings narrate for wonderful theoretical and empirical justification for the use of game-centered pedagogies in basketball training and education.

Despite this growing body of evidence, the use of game-based learning in basketball is still uneven in the coaching and physical education spaces. Many practitioners still use traditional methods because of a lack of pedagogical training, time constraint or lack of clarity about implementation strategies. Furthermore, while there have been several studies investigating tactical learning in invasion sports in general, those conducted specifically on basketball are fairly limited in relation to the specific situation of tactical decision-making. This gap identifies

a need for a specific investigation into the contribution that game-based approaches to learning provide to the development of tactical decision-making skills in the context of basketball.

The present study fills this need by analyzing current literature concerning game-based learning and tactical decision-making in basketball (Waffak et al., 2022). By integrating some of the latest empirical research findings and theoretical views upon the tactical decision-making, this research aims to clarify the role that game-based pedagogical models play in supporting tactical decision-making development. The results of this investigation are designed to guide coaches, educators, and scholars looking for research-based attempts to improve tactical intelligence and decision-making competence among basketball players.

### **Game Based Learning as Education Sustainable Development**

Educational sustainable development refers to the development of learning systems that support long - term cognitive, social and skill development and not just short - term gains. In the field of basketball instruction, sustainable development equates to the pedagogical approaches to instruction and/or learning that lead to progressively better decision making, thinking critically and being able to adapt during different parts of engagement. Game-based learning is very consistent with these goals through learner-centered environments that foster active engagement, problem solving and situationism. By exploring tactical choices within the context of real game situations, players learn transferable skills applicable beyond the time spent in the practice spaces and sound foundations are created for both lifelong learning in sport and in other subject areas (Pineda-Martínez et al., 2023).

From a sustainability point of view, game-based learning of basketball also supports the case of inclusion and resilience practices. These methods can be adapted to suit different abilities and age groups and fit different educational contexts in order to be suitable for long term integration into the school curriculum and sport development programmes. Emphasizing enjoyment, intrinsic motive and meaningful participation enhances retention and decreases drop outs which are the key indicators of sustainable education. In addition, the formation of tactical awareness and autonomous decision making allows the learners to take ownership of their own learning, which reinforces goals of sustainable education - autonomy, adaptability and holistic development for physical education and sport pedagogy (Scurati et al., 2023).

### **Research questions**

- i. How does game-based learning influence the tactical decision-making skills in basketball learning?
- ii. To what extent game-based learning approach improve the learning as compared to traditional approach?
- iii. What is the relationship between game-based learning and tactical decision-making skills in basketball?

### **Research objectives**

- i. To examine the influence of game-based learning on the tactical decision-making skills in basketball learning.
- ii. To compare the effectiveness of game-based learning approach and traditional learning approaches?
- iii. To analyze the relationship between game-based learning and tactical decision-making performance?

## 2. Literature Review

### 2.1 Tactical Decision-Making in Basketball

Tactical decision-making is such an aspect of successful basketball performance. It concerns the capacity of perceiving relevant information about the environment, interpreting situations in the game and choosing the correct actions in relation to the emerging tactical problems. Decision-making in basketball is a complex process, as it involves constant switching between offense and defense, the quick passing of the ball, and constant opposition. Recent research represents tactical decision-making as such an interaction between perceptual awareness, cognitive processing, and motor execution and not as a pure cognitive function.

Empirical research in basketball shows that players with higher tactical competence have better anticipation ability and faster response and appropriate action choice in basketball game. The results from Rusmana and colleagues Rusmana et al. (2023) showed that basketball athletes tailored with tactical games + motivational encouragement have significant decision-making/skill execution improvement. These findings highlight the importance of training environments that challenge players cognitively while still keeping the training technically challenging.

Tactical decision-making is closely related to tactical knowledge, which combines both declarative knowledge of game principles and procedural knowledge about the execution of gameplay. Research shows that tactical knowledge is most effectively developed when players are placed in learning situations where they need to formulate their own active problem-solving and reasoning in context. Small sided and modified games have been shown to improve these processes of learning by simplifying the tactical problems, while maintaining the realism of the game (de Souza et al., 2024; Perdima et al., 2024).

### 2.2 Game-Based Learning Approaches in Sport

Game-based learning approaches include several different pedagogical models such as Teaching Games for Understanding or the Tactical Games Model and Game Sense. These models share common themes of learning through play, tactical problem solving and player-centered instruction (Wigraha et al., 2025). Over the past four years, the use of game-based approaches in enhancing decision-making, tactical awareness, and general game performance across invasion sports was proven with consistent results by systematic reviews and meta-analyses (Barba-Martin et al., 2022; Gonzalez-Valero et al., 2024).

One of the distinguishing characteristics of game based learning is the use of modified games that over accentuate certain tactical problems without losing representativeness. Such modifications may include changing the number of players, dimensions of the court, or rules, to draw the learner's attention to important tactical principles. Recent research highlights that these adaptations encourage more depth to the cognitive engagement and help to perceive the affordances to let the players make a better informed decision in-game (Araujo et al., 2023).

Game-based learning is also consistent with the theories of learning known as constructivism that understands that knowledge is actively constructed through experience and social interaction. In Basketball contexts, this means the coaching practice of a focus on questioning, guided discovery and reflective dialogue. Some evidence from recent intervention studies suggests that game-based models of instruction make players more autonomous and motivated, and more tactically intelligent, than traditional instruction (Harvey et al., 2020; Papagiannopoulos et al., 2023).

### **2.3 Teaching Games for Understanding and Tactical Games Models**

Game-based learning approaches include a variety of pedagogical models which focus on learning from play and tactical problem-solving. Common features included modified game formats, representative task design and learner-centered instruction. Rather than locking in tactics, instructors help learners work out ways of effective tactical response via questioning and feedback. This way we will encourage deeper cognitive engagement while supporting development of tactical awareness.

Recent systematic reviews provide strong evidence in favour of the effectiveness of game-based learning in sports. Gonzalez-Valero et al. (2024) Teaching Games for Understanding based interventions significantly enhanced decision-making and tactical performance when compared to the traditional practices. Similarly, Manninen et al. (2025) reported moderate to large impacts of game-based approaches on decision-making, knowledge acquisition and development of motor skills in a variety of educational and training contexts.

Game-based learning has also been linked with higher levels of motivation and participation. Wang et al. (2024) found that university students who were involved in basketball courses using the Tactical Games Model exhibited greater levels of motivation and engagement than when courses were taught using conventional educational methods. These motivational benefits are particularly relevant in educational settings, where it is important that people can be kept engaged for a long enough time to complete the process of learning.

### **2.4 Ecological Dynamics and Representative Learning Design**

One of the most widely-researched game-based pedagogical models is Teaching Games for Understanding. It focuses more on helping players understand tactical problems before refining technical execution so that players understand why skills are used and not just how to execute such skills. Research performed in the context of basketball has shown that the TGfU-based learning approach increases accuracy in decision-making and tactical awareness as well as the higher-order thinking skills (Waffak et al., 2022).

The Tactical Games Model is similar in principle; emphasis being placed on the tactical problems as the basis for instruction. Wang et al. (2024) reported the effectiveness of Tactical Games Model interventions that led to improvements in tactical understanding and decision-making of students as well as increases in motivation. These results indicate that tactical competence is best developed when technical skills are practiced in meaningful tactical contexts.

Despite their niceties, however, successful implementation of TGfU and tactical games approaches requires pedagogical expertise. Studies noted that instructors need to be proficient in designing suitable changes in games, as well as in facilitating reflective dialogue. However, evidence indicates that structured instructional frameworks and professional development may positively support teachers and coaches in using these models (Wigraha et al., 2025).

### **2.5 Small-Sided Games and Tactical Performance**

Small sided games are a very practical application of game-based learning considerations in basketball. By having smaller numbers of players, smaller courts, and rules, small-sided games help coaches address specific tactical aims whilst keeping it game representative. It is also found that small-sided games do have a positive effect on the tactical and technical aspects of

performance as it enhances players' involvement and decision-making opportunities (De souza et.al., 2024).

The Literature has shown that small sided basketball games improve player tactical awareness, passing decisions and spatial positioning. In recent studies conducted a study examine student-athletes who played structured small-sided games and report significant increase in technical proficiency and tactical execution. These findings add to the importance of small-sided games as a pedagogical tool in the development of decision-making skills (Perdima et al.2014).

Small-sided games also facilitate cognitive engagement through requiring more frequent occurrence of tactical situations for the players to solve. This extra through time helps to accelerate learning and encourages adaptability, especially for novice and intermediate players. Consequently, small-sided games are becoming more and more suggested as a fundamental part of a basketball training program.

## **2.6 Cognitive and Critical Thinking Perspectives**

Recent studies bring out the importance of critical thinking and thinking in tactical learning. Game-based approaches inherently encourage these skills as they require players to analyze situations, make evaluations, and make quick decisions. Ishak (2025), has demonstrated that problem-based-learning for basketball significantly improved the critical thinking abilities of students, and this could suggest that there is a good alignment between the game based pedagogies and cognitive development.

Although much of this research has been performed in sports like soccer, research findings are still transferable to basketball because of shared tactical structures. Gaviria Alzate et al. (2024) has clearly reported the improvements in tactical efficiency and procedural knowledge with a tactical critical thinking program, which indicates the importance of cognitive processes in tactical performance. These results support the inclusion of critical thinking objectives in basketball pedagogy.

## **Research Gap and Rationale**

Although significant progress has been made in understanding the benefits of game-based learning, there is still several gaps in the literature. First, many of the studies are concerned with only short-term interventions thereby leaving limited understanding of long-term development of tactical decision-making skills. As reported by Gaviria Alzate et al. (2024) Second, there is currently a shortage of basketball-specific research in comparison to studies of invasion sports overall. Finally, differences in the quality of the method and assessment tools complicate comparisons across studies, indicating a need for more standardized research designs (Araujo et al., 2023).

Despite a good amount of evidence supporting the use of games in learning, there are a number of gaps in the research surrounding basketball. Many research is focused on short-term interventions and this has prevented a deeper insight into long-term tactical development. Additionally, there have been differences in methodology in assessment tools and intervention design, which make it difficult to compare studies. There is also a need for more research that explicitly relates game-based learning approaches to tactical decision-making outcomes in basketball and at different age group and learning contexts.

Such gaps to be addressed is key in the progression of the evidence-based basketball pedagogy. By synthesizing the recent research and paying particular attention to tactical decision making,

the present study, helps in a better understanding of how game-based learning approaches can be used systematically for improving tactical competence in basketball. By synthesizing current literature and ensuring an explicit focus on this particular topic, namely tactical decision-making, the current study contributes to a more nuanced interpretation of the possible success in taking effective advantage of game-based learning approaches in basketball training and education contexts.

### **3. Research Methodology**

#### **Research Design**

This study used a quasi-experimental approach to research in order to determine the effectiveness of game-based learning interventions for basketball on tactical decision-making skills. The reason why this quasi-experimental design has been selected is that it allows researchers to compare instructional interventions in a real educational/training environment where designating experimental conditions subject to random assignment is not feasible in order to showcase their consequences and implications for real-life application. The design has been frequently employed in research in sport pedagogy to test game-based instructional models in terms of both cognitive and performance-related measurements (Gonzalez-Espinoza et al., 2021; Wang, 2025). The work compares the social cognitive benefits of a game-based learning intervention to a traditional domain direct learning strategy with the aim of characterizing differences produced in learning the tactical decision-making capabilities.

The intervention-based design is consistent with recent research in the field of basketball pedagogy which focuses on the paradigms of ecological validity and representative learning environments. By implementing the intervention in normal training or physical education environments, the research is certain that the knowledge is being learned in real world constraints that represent actual basketball situations (Araujo et al, 2023). The intervention process took 8-10 weeks. The participants participated in two to three training programs per week. We evaluated them a week prior to the intervention and right after the intervention. The schedule had been based on the exposure of the participants to the principles of learning-through- games based on the existing research in basketball pedagogy.

#### **Participants**

The participants for this study are youth or undergraduate-level basketball players who have prior experience playing basketball. Participants are selected through the process of purposive sampling in order to ensure that all participants have a basic understanding of basketball rules and basic skills. This is a consistent sampling strategy that fits in line with recent empirical research studies examining tactical decision-making in basketball and other invasion sports (Ortiz et al., 2023; Papagiannopoulos et al., 2023).

Participants are divided into two groups: an experimental group that is exposed to game-based learning instruction and a traditional technique-focused instruction for a control group. Both groups go through training sessions of equal duration and frequency to control for training volume. Ethical approval is obtained before data collecting and informed consent from all participants is obtained following institutional research ethics guidelines.

#### **Intervention Program**

The intervention program is carried out during an eight to ten-week span and has two to three sessions a week. The experimental group uses a game-based learning curriculum based on the principles of Teaching Games for Understanding and Tactical Games Model. Each session

starts with a modified small sided game focused on highlighting particular tactical issues aspects relating to spacing, offensive decision making/defensive positioning. These games are followed by guided questioning and reflective discussion for tactical awareness and decision-making (Gonzalez-Valero et al., 2024).

Task constraints such as numbers of players, size of court, scoring rules, etc. are systematically manipulated in order to induce players to perceive affordances and make effective decisions in realistic conditions. Technical instruction is integrated into the tactical context instead of taught in isolation in line with ecological dynamics and representative learning design as principles (Araujo et al., 2023).

The control group uses a traditional approach which focuses on isolated skill practice, repetitive skill/technical practice and coach choice of feedback. Tactical instruction in this group is mostly verbal and takes place in a non-game setting; this is the typical coaching practice which is often reported in training environments in basketball (Wang, 2025).

### **Instruments and Measures**

Tactical decision-making is evaluated with a validated instrument for game performance evaluation appropriate for basketball. The instrument is used to evaluate decision-making quality on offensive and defensive game actions, such as passing, shooting, movement without having the ball and defense responses. Such instruments have been extensively applied within recent studies on basketball and invasion sports to measure in-game cognitive performance (Ortiz et al., 2023; Gonzalez-Espinosa et al., 2021).

Video recordings of small-sided games are used to analyse the decision-making behaviour pre-intervention and post-intervention. Trained observers code the performance, using standardized criteria, to assure reliability. Inter-rater reliability is a technique that is used before the formal data analysis is conducted to make the results of the analysis more trustworthy. This observational methodology is consistent with recent research on highlighting the importance of objective measures of performance over self-reported data (Gonzalez-Valero et al., 2024).

### **Data Collection Procedures**

Pre-test data were obtained one week before the intervention in order to establish the baseline decision-making performance of the two groups. Participants participate in standardized small sided basketball games that are designed to evoke frequent decision making opportunities. The same procedures are repeated at the post-test time post-completion of the intervention period. All testing situations are given under the same environmental and instructional conditions to reduce any extraneous variability. Coaches and instructors participating in the intervention are first provided with an orientation to ensure fidelity of implementation, especially for the game-based learning sessions in which instructional fidelity is crucial to validation of outcomes (Papagiannopoulos et al., 2023).

### **Data Analysis**

Data analysis is carried out by the use of inferential statistical methods suitable for quasi-experiments. Descriptive statistics are calculated first in order to summarize participant characteristics and performance measures. Paired sample and independent sample statistical tests are used to analyze within-group and between-group differences in tactical decision-making scores from pre-test post-test.

Effect sizes are calculated in order to determine the magnitude of the intervention's impact, that is, coffered with statistical significance, practical significance. This analytical approach is coherent with recent intervention studies in basketball pedagogy and helps to interpret in a meaningful way the results of the study (Gonzalez-Valero et al., 2024; Wang, 2025).

### Validity and Reliability

A number of strategies are adopted in order to enhance the validity and reliability of the study. The use of validated assessment instruments and standardized observation protocol to support the validity of the measures. Training observers and establishing inter-rater reliability is one way that subjective bias in the coding of performance can be reduced. Intervention fidelity is monitored through use of a session checklists and periodic observation in order to ensure fidelity to instructional models (Gonzalez-Espinosa et al., 2021).

Internal validity is improved by controlling training duration and number of sessions as well as conditions of assessment among and across groups. External validity is ensured by conducting the research in real basketball situations that contributes to the relevance of results for more practical coaching and teaching settings.

### Ethical Considerations

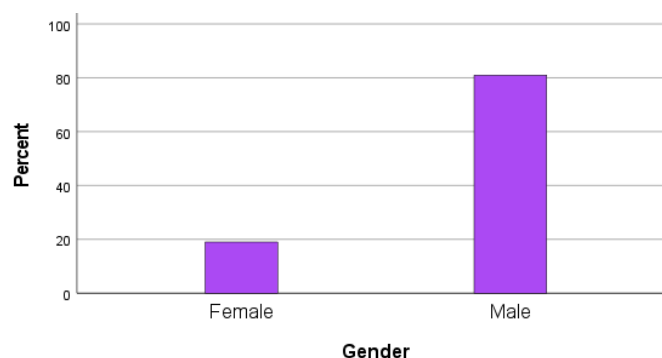
Ethical considerations are covered at each point throughout the research process. Participation is voluntary and participants are made aware of their right to withdraw from the program at any time without penalty. Confidentiality is provided for by the anonymization of data and the limited access to research materials. The study follows ethical guidelines given for the research among human subjects in sport and in educational settings.

## 4. Results

**Table 1: Gender of the participants**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Female	19	19.0	19.0	19.0
	Male	81	81.0	81.0	100.0
	Total	100	100.0	100.0	

Table 1 shows the gender distribution among the subjects and there is a clear predominance of males. Of the general population of 100 subjects, 81 (81%) were male and 19 (19%) were female. The valid and cumulative percentages indicate that there is no missing data in the dataset and that males form the majority of the population in the study. This imbalance represents the greater involvement of males in basketball related activities and programs within the institutions sampled and needs to be considered when determining the generalizability of findings to genders.



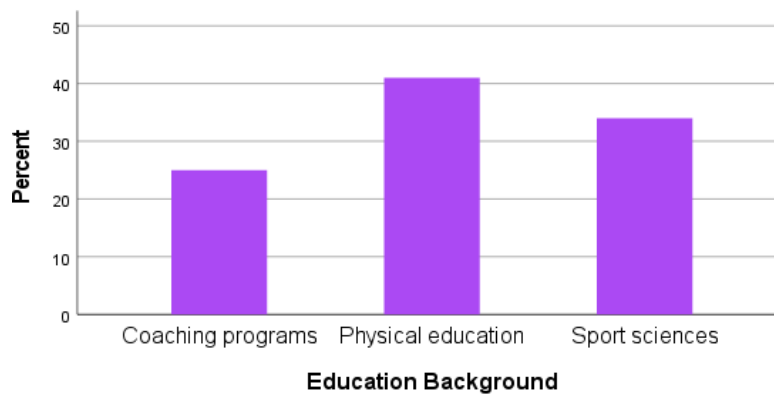
**Figure 1: Bar chart for the Gender of the participants**

Table 2 presents the education level of the participants which indicates a spread in the basketball-related disciplines. Among the respondents, 41% were engaged in physical education programs and thus the highest population compared to the other groups of 34% in sport sciences and 25% in coaching programs. The cumulative percentages indicate an entire distribution among the three categories but no missing data. This distribution indicated that the sample is reasonably representative of individuals that have formal academic exposure to basketball and sport related education relevant when examining learning and decision-making outcomes.

**Table 2: Educational Background of the participants**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Coaching programs	25	25.0	25.0	25.0
	Physical education	41	41.0	41.0	66.0
	Sport sciences	34	34.0	34.0	100.0
	Total	100	100.0	100.0	

Table 3 summarizes age distribution for the age range among the participants (16 to 25 years) representing school, college, and university-level basketball players. The highest proportion of study participants were 23 years of age (15%), followed by 24 years of age (12%) and 22 and 25 years of age (11% each). Younger age groups like 16 and 21 years represented comparatively less. Overall the age distribution shows that there is a balanced distribution across late adolescence and early adulthood in order to include those at different developmental stages of tactical learning in basketball.



**Figure 2: Bar chart for the Educational Background of the participants**

**Table 3: Age of the participants**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	16	7	7.0	7.0	7.0
	17	10	10.0	10.0	17.0
	18	9	9.0	9.0	26.0
	19	9	9.0	9.0	35.0
	20	10	10.0	10.0	45.0
	21	6	6.0	6.0	51.0
	22	11	11.0	11.0	62.0
	23	15	15.0	15.0	77.0
	24	12	12.0	12.0	89.0
	25	11	11.0	11.0	100.0
	Total	100	100.0	100.0	

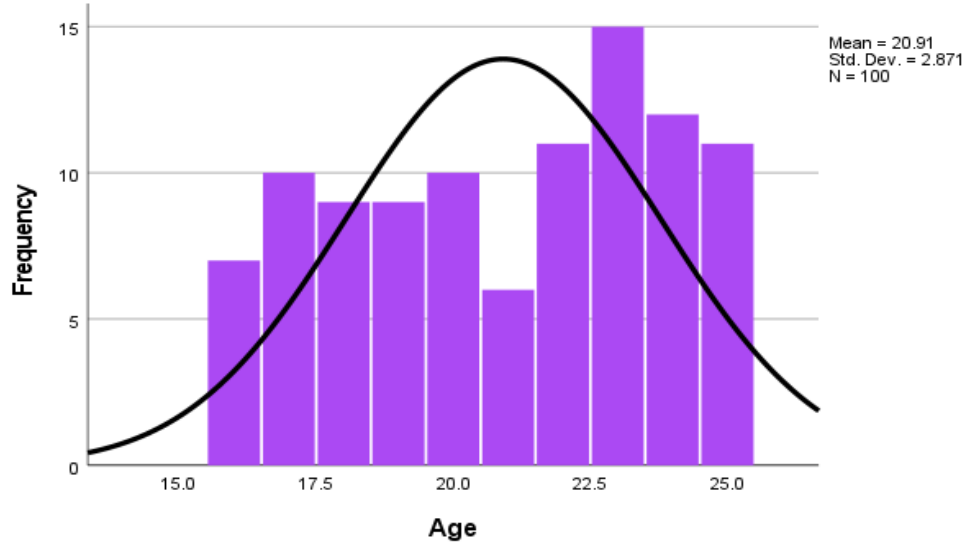


Figure 3: Histogram for the Educational Age of the participants

Table 4: ANOVA for the comparison of the Pre and Post Intervention for the Tactical Decision-making Skills

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	62.922a	1	62.922	191.738	.000
Intercept	2190.823	1	2190.823	6675.964	.000
Tactical Decision-making skills	62.922	1	62.922	191.738	.000
Error	64.977	198	.328		
Total	2318.721	200			
Corrected Total	127.899	199			

a. R Squared = .492 (Adjusted R Squared = .489)

Table 4 reports the results of the ANOVA performed to compare pre- and post-intervention scores for tactical decision-making skills. The analysis determined that there was a statistically significant effect of intervention specifically F value 191.738, significance level  $p < .001$ . The model explained around 49.2% of variance in tactical decision-making skills as measured by R-squared value thus there is a significant intervention effect. These results suggest that the intervention resulted in a meaningful improvement of participants in their tactical decision-making skills.

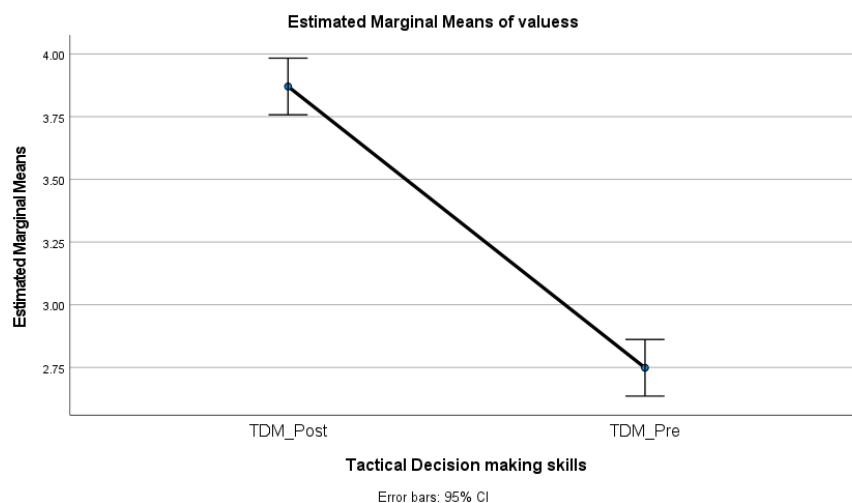


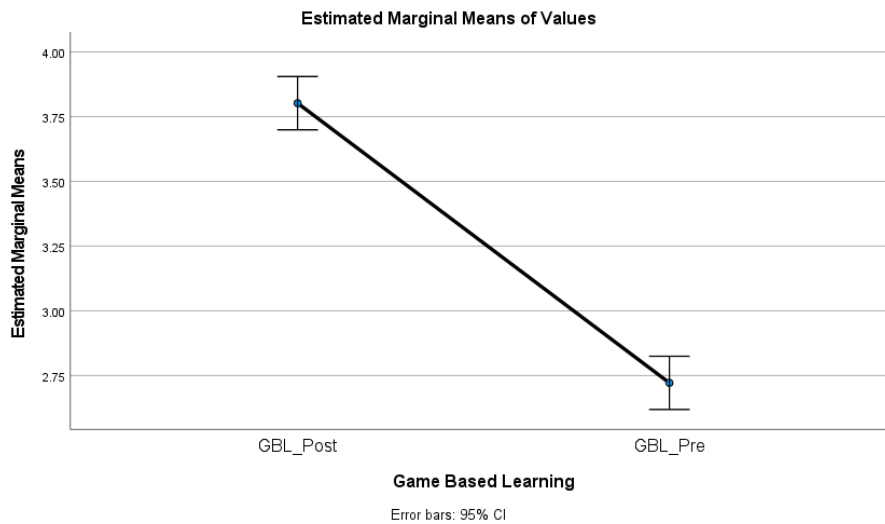
Figure 4: Line Graph for the comparison of the Pre and Post Intervention for the Tactical Decision-making Skills

**Table 5: ANOVA for the comparison of the Pre and Post Intervention for the Game Based Learning**

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	58.352a	1	58.352	214.874	.000
Intercept	2128.325	1	2128.325	7837.242	.000
Game Based Learning	58.352	1	58.352	214.874	.000
Error	53.770	198	.272		
Total	2240.447	200			
Corrected Total	112.122	199			

*R Squared = .520 (Adjusted R Squared = .518)*

Table 5 shows the results of the statistical analysis (ANOVA) to evaluate the differences in game-based learning scores before and after the intervention. The results indicate a statistically significant improvement with F value 214.874 and significance level of  $p < .001$ . The R-squared value of .520 means that 52% variability in game-based learning outcomes is accounted for by the intervention. This aforementioned strong effect implies that the approach for game-based learning was quite effective to improve people's learning experiences and performance.



**Figure 5: Line Graph for the comparison of the Pre and Post Intervention for the Game Based Learning**

**Table 6: Pearson Correlation for the relationship between Game Based Learning and Tactical Decision-Making Skills**

		GBL Mean	TDM Mean
GBL	Pearson Correlation	1	-.135
	Sig. (2-tailed)		.180
	N	100	100
TDM	Pearson Correlation	-.135	1
	Sig. (2-tailed)	.180	
	N	100	100

Table 6 presents the Pearson correlation analysis performed for the purpose of exploring the correlation relationship between game-based learning and tactical decision-making skills. The results show a weak negative correlation ( $r = -.135$ ) between the two variables that was not statistically significant ( $p = .180$ ). This suggests that within the currently sampled group of people, game-based learning scores were not directly related to tactical decision-making skill-levels. The lack of a significant correlation suggests that there may be other factors that are influencing the relationship between these variables, and it should be investigated further.

## 5. Discussion

The results of the current study offer summary empirical evidence of the success of game-based learning and tactical-oriented instructional strategies in enhancing tactical decision making skills of the participants playing basketball. The results of the multiple analysis of variance (ANOVA) showed that there were statistically significant improvements in both tactical decision-making skills and game-based learning outcomes after the intervention, with large effect sizes reflected in  $R^2$  of .492 and .520, respectively. These findings are very consistent with contemporary literature that focuses on the pedagogical merit of game-centered and tactical models in basketball pedagogy.

Consistent with the systematic review, by de Souza et al. (2024), the present results suggest that small sided and game-based learning environments increase players tactical and technical performance by increasing contextualized decision-making opportunities. Similarly, Perdima et al. (2024) found that structured small-sided basketball games have a significant impact on technical proficiency and situational awareness, supporting the improved post-intervention performance gains in tactical decision-making in this study. The large gain seen as a result of analytics using an Analysis of Variance (ANOVA) further supports the case that learning in representative game environments allows for greater depth of tact knowledge as compared to traditional drill based learning.

The effectiveness of game-based learning is also backed by the motivational and cognitive perspectives. Wang et al. (2024), for example, showed that tactical games models improve the motivation and engagement of university students when they take courses in basketball, which probably results in positive learning outcome. Increased motivation may have mediated in the present research to allow participants to actively participate in problem-solving situations inherent in game-based tasks. This interpretation is enforced by Fauziah et al. (2025), where the authors found that game-based learning models significantly increased student participation and active involvement in physical education settings.

The increase in tactical decision-making is in line with the finding of Ishak (2025), which presented that the effectiveness of problem-based learning basketball can predict the development of the critical thinking skills in students. Tactical decision-making is by its very nature coupled with such critical thinking processes as perception, anticipation, and evaluation of alternatives. Similarly, Gaviria Alzate et al. (2024) showed that tactical critical thinking programs increased tactical efficiency and procedural knowledge, which may suggest that structured tactical interventions can produce meaningful cognitive and performance-related improvements.

Despite the high levels of improvements in both constructs, a weak and non-significant association of game-based learning to tactical decision-making skills was found. This results in a contradiction to other studies that reported substantial associations between tactical performance and physical fitness variables (Silva et al., 2023). The lack of a significant correlation in the present study may suggest that improvements in tactical decision-making may be based on several factors interacting such as previous experience, cognitive maturity, as well as instructional design, rather than game-based learning. It also implies that both variables may have improved with the intervention but that this may be in parallel, and not directly interdependent, outcomes.

From an instructional point of view, these results are consistent with those outlined in other reviews both on a pedagogical broader (Breed et al., 2025) and specific (Wigraha et al., 2025) level that highlighted the superiority of tactical and game-centered approaches over traditional ones in physical education. The results can be added to a growing consensus on sports, beyond football (e.g., Piri et al., 2026), that game-based learning supports tactical awareness by placing the learner in a realistic tactical decision-making environment.

## **6. Conclusion**

This study concludes that game-based learning interventions have a significant effect on tactical decision-making skills and learning outcomes of basketball participants. The statistically significant differences between pre- and post-intervention prove the efficacy of tactical and game-centered instruction approaches. However, the fact that game-based learning did not have a significant correlation with tactical decision-making appears to indicate that tactical skill development is multifactorial and is not strictly dependent upon instructional format. These results support findings within the literature on game-based pedagogy but highlight the importance of integrating instructional designs that include cognitive, motivational, and experiential dimensions of learning basketball. Game-based learning of basketball also supports the case of inclusion and resilience practices as education sustainable development. Game-based learning is very consistent with these goals through learner-centered environments that foster active engagement, problem solving and situationism.

### **Limitations of study**

The study yielded meaningful results but it possesses a number of limitations. First, the quasi-experimental design does not allow concluding about a casual inference which would have been achieved in a randomized controlled trial. Second, only unprofessional and young undergraduate basketball players were chosen, which did not allow generalizability of findings to the elite and professional athletes. Third, the intervention duration was short, preventing conclusions about long term retention. Lastly, observational coding despite being confirmed through inter-rater reliability tests still involve the subjective interpretation.

### **Future Research Direction**

The long-term effect of the game-based research on the overall tactical decision-making should be evaluated using longitudinal studies in the future. External validity would be strengthened by the inclusion of the participants of varying levels of competition and, in particular, elite and professional athletes. Mediators that should be studied by the researchers include motivation, cognitive load, and previous game playing experience such that the role of game-based learning on tactical performance can be better comprehended. This should be supplemented with mixed-method approaches (including the use of qualitative information as a reflection of players and interviews with coaches to gain better understanding of the interaction between learning and teaching in different contexts of basketball).

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### **Conflict of Interest**

We have no conflicts of interest to disclose.

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