# ENHANCING FREE-THROW SHOOTING THROUGH BODY POSITIONING: INPUTS FOR BASKETBALL TRAINING PROGRAM



# PSYCHOLOGY AND EDUCATION: A MULTIDISCIPLINARY JOURNAL

Volume: 18 Issue 9 Pages: 856-862 Document ID: 2024PEMJ1720 DOI: 10.5281/zenodo.10964685 Manuscript Accepted: 03-15-2024

# Enhancing Free-Throw Shooting Through Body Positioning: Inputs for Basketball Training Program

Madel S. Bulahan,\* Ralph Chister L. Balongcas, Christian I. Almero, Midylin B. Erodias, Jirah Grace Tondo, Milagros Aurea A. Sabidalas, Mary Grace G. De La Cruz For affiliations and correspondence, see the last page.

#### Abstract

The study, which was anchored to Galileo Galilei's projectile motion and Newton's Three Laws of Motion, aimed to improve the performance of basketball players in terms of free-throw shooting through exact body positioning and the most preferred angle according to their height. The ability of the player to shoot, specifically free throws, can determine the outcome of the game. Shooting involves different factors, specifically the position of the body and the angle of the ball before it is released. To prove this position, the researchers conducted an experiment with five (5) selected basketball players who were chosen based on the inclusion criteria. The participants made 10 consecutive free throws at different body positions and angles in three (3) trials. Scoring was done by counting the successful free throws. Results revealed that the average number of free-throw basketball players' score at an angle range of 41°-45° was 5.40; at an angle range of 46°-50° was 5.07; and at an angle range of 51°-55° was 5.80. The average number of free throws a basketball player score at different angle ranges according to their height was also revealed. Difference analysis in the number of free throws the participant can score at different angle ranges and heights revealed a non-significant result. Overall result showed that every player maintains consistency in every aspect and is unique in terms of their ability to throw the ball in any direction.

Keywords: basketball, free throw, body positioning, angle range, players' height

# Introduction

Projectile motion plays a crucial part in our daily activities, and it occurs most frequently in sports, specifically basketball. Basketball is a team sport played on a rectangular court with a variety of technical and tactical actions that contribute to the multilateral development of athletes in terms of motor, functional, technical, and tactical aspects. Basketball is a sport that makes use of a lot of projection actions, particularly in shooting. No matter which direction it is being shot, either forward or upward, the ball will swish through the basket due to the projectile motion (Nor-Al-Din et al., 2021b).

In addition, basketball players' motor skills and creativity are stimulated by the game's sequence and complexity of phases, which allows them to reach their full tactical, technical, and physical potential. The success of a free throw is contingent upon several factors, including the alignment of specific movements with respect to the player's ability, the postures adopted during the throw, its trajectory, and the degree of consistency between the movement's angles and the throw's pace (Olteanu et al., 2023).

According to Pakosz et al. (2021), basketball players typically practice repeated free-throw shooting drills to hone a consistent shooting technique. Basketball players, on the other hand, need to concentrate on comprehending the ideal conditions for free-throw performance. To do this, they should be aware of the degree of ball release angle, where the ball should be aimed, how much backspin should be applied to the ball, whether it is advantageous to release the ball higher above the ground, how to make the throw quickly, and other crucial elements required for the mastery of the most effective free-throwing technique. Moreover, the free-throw issue was the most well-known difficulty among players in basketball competitions. In basketball, where free throws account for 20% of points scored, free throws are seen as crucial shots that require specialized abilities since the offensive player must exert total control over every aspect of the shot (Sukri et al., 2021).

In school-based activities such as intramurals and sports festivals at Kabankalan Catholic College, free-throw is considered one of the fundamentals, specifically the basics of basketball. However, it is not given emphasis, leading to a lack of intervention in improving the skills of the players in free-throw. One reason is that since it is free in nature, there is no opponent that will block the ball in the act of shooting. Hence, a lack of practice led to the inconsistency of the players in efficiently shooting the ball, including proper body positioning in the act of shooting.

The main purpose of this study was to improve the knowledge of the possible free-throw technique by determining the contribution of free-throw shooting to the success of basketball players in different angle ranges. The researchers conducted this study to determine which angle a basketball player should use when shooting free throws. The results of this research served as baseline data in designing one of the aspects of the basketball training program, which is shooting skills.

## **Research Questions**

The goal of this study was to determine the ideal angle for basketball players based on their height and how to precisely position their bodies to shoot free throws. Specifically, this study sought answers to the following questions.

1. What is the average number of free throws a basketball player can score at different angles?

- 1.1 angle range 41°-45°
- 1.2 angle range 46°-50°
- 1.3 angle range 51°-55°

2. What is the average number of free throws a basketball player can score at different angle ranges according to height?

3. Is there a significant difference in the number of free-throws that a basketball player can score at different angle ranges according to height?

# Literature Review

This study focused on enhancing free-throw shooting through body positioning. With this, the following related studies were provided to further discuss the terms and problems found in this study.

#### **On Body Positioning**

Body positioning plays a crucial part in playing different sports like basketball, especially free-throwing. The ability to hit free throws is one of the most important skills needed by a basketball player. The arm muscle activation during a free throw and its fluctuations varies along with the training experience of basketball players. The variability of the muscle activation time in precise free throws was observed in all player groups under study. Free-throw speed is irrelevant for free-throw efficiency. Thus, free-throw shooting in basketball requires specialized skills because the offensive player must exert total control over everything. For a set amount of time, the player will simply need to shoot the ball continuously (Pakozs, 2021).

In addition, the technical jump, shots, parabola forces, and other actions that take place during a basketball game all make reference to basic physics and mathematics. Basketball is most likely one of the sports where parabolic motion is most obvious and occurs most frequently throughout the game. The ball moves uniformly at oblique speed, which causes it to rise, and uniformly downward due to the force of gravity, which causes it to fall. These two motions determine the ball's trajectory. A basketball player tosses the ball in a parabolic trajectory toward the basket. Raising the parabola's apex much above the basket, which is situated at the top of the court, will improve the likelihood that the player will score the point (Giovanni, 2022).

#### **On Free Throw Shooting**

Basketball free throw shooting is a simple sport skill that anyone can practice and master to the level of a professional player. This is due to the fact that players will only need to hurl a nine-inch-wide, twenty-ounce ball onto a rim with an eighteen-inch circumference to make the shot. The results of many contests can be significantly impacted by the points scored during a free throw. Typically, the team that can score more points during the free throws will win the game. Given that the player is acting alone and is not being pressured by the defense, it should be easier to make the free throws. However, the majority of players have difficulty scoring since they are not skilled enough, especially when it comes to determining the correct throwing angle (Nor-Al-Din et al., 2021b). Basketball coaches spend a lot of time instructing the free-throw shooting motion, which makes sense given the player is acting alone and is not being pressured by the defense or the other side. However, the majority of players have difficulty scoring since they are not skilled enough, especially when it comes to determining the correct throwing angle (Nor-Al-Din et al., 2021b). Basketball coaches spend a lot of time instructing the free-throw shooting motion, which makes sense given the potential influence a strong performance can have on the total number of points scored in the final game. It is because the player is acting alone and is not being pressured by the defense or the other side. However, the majority of players have difficulty scoring since they are not skilled enough, especially when it comes to determining angle (Nor-Al-Din et al., 2021b). Basketball coaches spend a lot of time instructing the free-throwing angle (Nor-Al-Din et al., 2021b). Basketball coaches spend a lot of time instructing the free-throwing angle (Nor-Al-Din et al., 2021b). Basketball coaches spend a lot of time instructing the free-throw shooting motion, which makes sense given the potential influence a strong performance can have on the total numbe

Even though the free-throw shot has been considered one of the easiest uncontested shooting motions in the game of basketball, many players on various levels of competition struggle with its optimal and consistent execution. To execute free-throw shooting, the alignment of the shoulder must be maintained; bend the shooting arm, aim the elbow straight to the rim, and keep it close to the ball. This will become automatic with time and won't require any thought. It is advisable to direct your attention to your target with your eyes (Cabarkapa et al., 2021). According to the University of Science and Mathematics in Malaysia (2019), free throws in basketball are actually a simple element of the sport that anyone can practice and may perform as competently as professional athletes. This is due to the fact that each shot will only require the players to toss a ball that is nine inches wide and weighs approximately twenty ounces into a rim that is eighteen inches in diameter. In many competitions, the points scored during the free throw may considerably change the results. The team that is able to get a higher score during a free throw usually wins the game. The shooting of the free throw actually should be easier since the player is working alone, without any defense or pressure from the opposing team. Yet the lack of skills, especially in estimating the right throwing angle, makes most of the players fail to score.

#### On Angle Range

When figuring out the best angle to throw the ball for optimum distance, more physics is involved. The ball won't descend far before hitting the ground if it is thrown too low, possibly horizontally. The angle for a horizontal throw would be 0 degrees, and the angle for a straight up throw would be 90 degrees. If there is no air resistance, they would get the maximum distance by throwing at a 45° angle, but if there is no air resistance, the ball is thrown, the more air resistance there is. Also, the ball must slow down for a longer period of time due to air resistance the longer it is in the air. In order to reduce the amount of time the ball spends in the air and the

amount of energy lost to air resistance; the throw that travels the longest will be made at an angle less than 45°. It is true that the angle for maximum distance varies depending on how swiftly the ball is thrown; therefore, it is understandable that different players would come to different conclusions about the ideal angle (Nordland, 2019).

Moreover, angle of release is crucial since it impacts how the projectile moves; in badminton, a steep slope will cause the projectile to fly off in a curve and be challenging to control, and it determines how quickly the opponent can move to block. The shuttle's angle of release has an impact on the shuttle's speed and direction when playing badminton. The optimal angle of release in badminton is 45 degrees because, when releasing a product, it is important to release it at an angle that will have the desired effect. The optimal angle of release for products such as medications and vaccines are 45 degrees. This allows the product to be dispersed evenly and reach its target quickly without encountering any obstacles (Liuzhou, 2023).

Furthermore, soccer players frequently claim that the top of the 18-yard box provides the ideal range point from which to score goals. This is because shots from this angle are harder to save because the goalkeeper is normally positioned in the middle of the goal. A successful game can be greatly increased by knowing the ideal angles to strike the ball. Typically, goals should be approached at angles to the side or directly in front of them. Kick the ball toward the goal with your top foot. When making contact with the center of the ball, it's imperative to maintain a foot angle between 45 and 55 degrees. When comparing the maximum output value of the sine function to 1, with an input angle of 90 degrees, the research found that for the longest punts, two \*= 90 degrees and one \*= 45 degree. As a result, the projectile has a range of up to 45 miles when it is launched at a 45-degree angle (Johnny, 2023).

## Methodology

The researchers utilized the experimental method in this study. Experimental research is a methodology used to gather information and data on a subject through observation in controlled settings (Faltado et al., 2017, as cited in Sabidalas, 2024). Also, it helps to execute the research objectives with more clarity and transparency.

The participants of the study were the five (5) Bachelor of Arts in Philosophy student athletes enrolled at Kabankalan Catholic College who were selected based on the following inclusion criteria set by the researchers. Specifically, the criteria include the athletes' technical aspect consisting of their performance in shooting, dribbling, rebounding, passing, and defense (50%), their physical aspect consisting of their strength, speed, stamina, and agility (20%), the tactical aspect consisting of the athletes' skills in decision making, awareness during the game, ability to communicate with other players, and skill in positional play (20%), and the psychological aspect consisting of their attendance, commitment, leadership, and ability to play with their team (10%).

In conducting the experiment, the researchers used the following materials: five (5) basketballs of the same brand, weighing  $1\frac{1}{2}$  kilograms each; an improvised goniometer; measuring tape; a meter stick; a basketball rim; a weighing scale; and a tally sheet.

Moreover, the following procedures were followed during the course of the study: Before the conduct of the experiment, a letter asking permission was forwarded to the Little Way College Seminary Rector for approval of the participants and the use of the facilities in the seminary. Upon the rector's approval, the researchers proceeded with the selection of players who would participate in the experiment. The researchers recruited ten (10) participants who were proficient in playing basketball. Only five (5) players were considered qualified based on the inclusion criteria provided by the researchers.

#### **Ethical Considerations**

For ethical consideration, the participants underwent a physical examination conducted by the school physician to ensure that they were in good health and had no medical conditions. They were found healthy and free from injuries that may affect their performance. After that, another letter of request was forwarded to the statistician to help guide and assist the researchers in computing the results.

During the conduct of the experiment, the researchers started conditioning the five (5) selected players through training by applying the different fundamental skills in basketball, specifically the shooting skill. Each participant provided a brief demonstration of the correct body positioning in free throw shooting. All participants went through the warm-up activity first before they were allowed to practice to avoid injury.

Additionally, during this period, the players applied the bending position in shooting. The researcher then tallied the number of successful shots at a given angle. The researchers used a video camera to record each free-throw shooting performance and a tally sheet to list the number of successful free-throw shots. In measuring the angle range, they used an improvised goniometer to measure the joint angle before the player released the ball. Furthermore, they used a meter stick as a guide in the goniometer to ensure that the released ball hits the exact trajectory in the specific angle range. Three (3) trials were conducted, and the players were made to shoot 10 consecutive free throws for each trial. The researcher recorded the number of successful free throws in every trial.

Documentation was done by the researchers during the conduct of the experiment, after which the data gathered was referred to the statistician for tabulation and interpretation of the results.



Range of Scores	Level of Free-throws	Description
7-10	High	The athlete exceeds core requirements in term of body positioning, skills and understanding.
4-6	Average	The athlete develops core requirements in term of body positioning, skills and understanding.
0-3	Low	The athlete develops core requirements in term of body positioning, skills and understanding but needs little guidance from the coach and assistance from peers.

The interpretation of the number of free throws is as follows:

On the other hand, the researchers used the mean to measure the average number of successful free throws a basketball player can score at different angle ranges. They used the two-way analysis of variance (ANOVA) to determine the significant difference in the number of successful free throws that basketball players score at different angle ranges.

#### **Results and Discussion**

Table 1.1 shows that the average number of free throws scored by the players at a shooting angle of 41-45 degrees is around 5-6. This indicates that the players have a decent level of accuracy at this shooting angle, except for one player who scored 3.67, which is relatively low compared to the other players. This implies that the four players exhibit consistent shooting mechanics and control over their shot release from 41-45-degree angles, resulting in a reliable average score between 5 and 6. They likely maintain proper form, angle range, and shooting rhythm, allowing them to consistently convert their attempts from this range. The arc of the shot is the secret to making a good foul shot in basketball. Using the free throw line as the reference, a 45-degree arc was the best (Sullivan, 2022).

14010 1.17	Iveruge nu	mber of fr	e-mows	buskelbuli pluyers score ul ungle i	runge. +1 -+5	
Player	Trial 1	Trial 2	Trial 3	Average Number of Free Throws	Interpretation	
1	5	9	3	5.67	Average	
2	7	6	7	6.67	Average	
3	1	6	4	3.67	Low	
4	4	7	5	5.33	Average	
5	8	7	2	5.67	Average	
Mean	5	7	4.2	5.40	Average	

Table 1.1 Average number of free-throws basketball players' score at angle range:  $41^{\circ}$ - $45^{\circ}$ 

Table 1.2 shows the average number of free throws made by the players at the 46–50 degree shooting angle is relatively consistent among the players. The average ranges from 4.00 to 6.67, with most players falling around the 5.00 mark. This indicates that, on average, these players have similar performance when shooting free throws from this particular angle. This implies that the players' shooting performance from these angles is fairly average. They are able to make approximately half of their shots from these angles, indicating they have some skill and proficiency in shooting from these angles. However, player 1 is not consistently making a higher percentage of shots. The decrease from 7 to 3 indicates a significant drop in accuracy or success rate. This player is experiencing difficulty consistently making successful shots. The hypothesis of the experiment of Avery and Draffin (2020) suggested that if the subject's angle of release is between 45 degrees and 50 degrees, then the subject will make a higher percentage of players' shots.

1 4010 1.27	werage na	iniber oj jr		oushcibuli pluyers score ul ungle l	runge. 40 50
Player	Trial 1	Trial 2	Trial 3	Average Number of Free Throws	Interpretation
1	7	5	3	5.00	Average
2	7	7	6	6.67	Average
3	4	5	6	5.00	Average
4	3	3	6	4.00	Average
5	3	5	6	4.67	Average
Mean	4.8	5	5.4	5.07	Average

Table 1.2 Average number of free-throws basketball players' score at angle range:  $46^{\circ}$ - $50^{\circ}$ 

Table 1.3 shows the average number of free throws made at a 51–55-degree angle varies across trials and players. Player 2 has the highest average of 7.00, indicating consistent performance and a higher likelihood of making more free throws compared to the other players. This player can be considered skilled at scoring free throws from this angle. Players 1, 3, and 5 have average scores ranging from 5.33 to 6.00. These players can be categorized as having average performance in scoring free throws from this angle. They are relatively consistent but not as proficient as Player 2. Optimizing the release height during the jump shots recommended that shooters aim to achieve a release angle of between 49 and 55 degrees above the horizontal plain (Cabarkapa et al., 2022).

Table 1.3 Average number of free-throws basketball players' score at angle range: 51°-55°							
Player	Trial 1	Trial 2	Trial 3	Average Number of Free Throws	Interpretation		
1	5	5	6	5.33	Average		
2	6	8	7	7.00	High		
3	4	6	6	5.33	Average		
4	4	2	5	3.67	Low		
5	6	7	5	6.00	Average		
Mean	5	5.6	5.8	5.40	Average		

There is a clear pattern in the players' performance across a range of angle ranges, as seen by the results presented in Table 1.4 about the average number of free throws at various angles. As shown in the table, the average number of free throws stays generally close, with small variances, for angles between 41 and 45 degrees, 46 and 50 degrees, and 51 and 55 degrees. Moreover, the players' free throw performance appears to be very consistent across the observed angles, as indicated by the insignificant changes in average scores between the various angle ranges. Even while there might be small differences, they are not statistically significant enough to allow for the creation of meaningful performance differences based only on the free throw's angle.

Additionally, the negligible differences in average scores among the different angle ranges imply that the players' free throw performance is relatively uniform across the observed angles. While slight variations may exist, they are not statistically significant enough to draw meaningful distinctions in performance based solely on the angle of the free throw. Khan (2019) stated that the central value of a set of numbers is all a common measure.

Table 1.4 Summary of the average number of free-throws basketball players score at different angle range	es
--	----

Angle Range	Trial 1	Trial 2	Trial 3	Average Number of Free Throws	Interpretation
41°-45°	5.00	7.00	4.20	5.40	Average
46°-50°	4.80	5.00	5.40	5.07	Average
51°-55°	5.00	5.60	5.80	5.47	Average

Table 2 shows the different heights of the players in meters and the interpretation of free throws in different angle ranges. In 1.65 meters of height and in angle ranges of 41-45 degrees, the player garnered a score of 5.33; in 46–50 degrees, 5.56; and in 51–55 degrees, 5.89, which are all interpreted as average. In 1.73 meters of height and in angle ranges of 41-45 degrees, the player garnered a score of 5.67; in 46–50 degrees, 4.67; and in 51–55 degrees, 6.00, which are all interpreted as average. Lastly, in 1.74 meters of height, in angle ranges of 41-45 degrees, the player garnered a score of 5.33, and in 46–50 degrees, 4.00, which is interpreted as average. However, in the angle range of 51-55 degrees, the player garnered a score of 3.67, which was interpreted as low. The average identifies the general location of points, whereas variability quantifies the dissimilarity. This is crucial because the level of variability affects how well results from the sample can be generalized. The central tendency of two data sets may differ from the levels of variability, or the opposite may be true (Bhandari, 2023b).

Table 2. Average numbers of free throws can a basketball player's score at different angle ranges according to Height

	Angle Range							
_	Height (m)	41°-45°	Interpretation	46°-50°	Interpretation	51°-55°`	Interpretation	
_	1.65	5.33	Average	5.56	Average	5.89	Average	
	1.73	5.67	Average	4.67	Average	6.00	Average	
	1.74	5.33	Average	4.00	Average	3.67	Low	

As shown in table 3, no significant differences exist among angle ranges and heights. This means that regardless of the range and height, the players scores in free throwing are almost the same. Non- significance in statistics means that the null hypothesis cannot be rejected. Boyd (2021) stated that non-significant results may be because the researchers do not have statistical evidence that the difference in groups is not due to chance.

Table 3. Difference Analysis in the number of free- throws that a basketball player can score at different angle ranges and heights

,						33	. 0
	Variables	DF	F-Value	R-Squared	p-value	Conclusion	_
	Columns (Angle Range)	2	1.695	0.146	0.146	Not Sig.	
	Rows (Height of Players)	2	0.456	5.40	0.618	Not Sig.	
	Interaction	4	0.590	5.80	0.672	Not Sig.	_

## Conclusion

To sum up, the examination of free throw performance at various angle ranges indicates that players demonstrate a constant degree of skill no matter what angle they are shooting from. The players' ability to adjust their shooting technique from different angles is highlighted by the little differences in average scores, which show consistency in performance. Even though there may be little variation, they do not become statistically significant, suggesting that the free throw's angle alone does not significantly affect the results of performances.

Considering the study's outcomes, therefore, it can be said that players' average number of successful free throws is not significantly affected by the free throw angle within the given ranges. This finding emphasizes the significance of maintaining consistency and mastery in one's free throw shooting technique, irrespective of the particular angle. It might be necessary to conduct more research to examine variables other than angle differences that could affect free throw performance.

Based on the data gathered, statistical results and conclusion, the following recommendations are offered:

**School Administrators.** Since the Kabankalan Catholic College offers Bachelor of Physical Education it will be beneficial for the students to have training equipment to use. Hence, we recommend for the school to purchase training equipment like an automated shooting machine. The school must invest with an automated shooting machine that allows players to practice shooting with precision

and repetition. This machine is capable of simulating game-like scenarios, adjusting for varying distances and angles, and providing instant feedback on shooting form, accuracy, and trajectory, ultimately leading to improved overall performance.

**Sports Coordinators.** Encourage coaches to attend workshops or training sessions that emphasize the importance of body positioning in free-throw shooting. Provide resources such as instructional videos, articles, or expert consultations to help coaches develop their understanding and teaching methodologies related to body positioning for free throw.

**Basketball Coaches.** As direct trainers, they may incorporate targeted drills focusing on body positioning, including shooting angles, balance, and alignment, into basketball training programs. Develop tailored training programs that focus on optimizing body positioning for improved free-throw shooting accuracy.

**P.E. Teachers.** As curriculum implementers, teachers may provide clear explanations and demonstrations of proper body positioning during free-throw shooting, emphasizing key elements such as foot placement, angles, hand positioning, and body alignment.

**Athletes.** Being the main subject of the study, they should dedicate ample time to shooting free throws during practice sessions. Focusing on shooting from the prescribed angle repeatedly will help their body adapt and reinforce the correct shooting motion and specific adjustments to their shooting skills leading to improved accuracy and consistency.

**Future Researchers.** Future researchers will use advanced equipment to measure an accurate shooting angle for basketball players. They may use equipment like:

**a. High-resolution cameras.** The equipment will incorporate high-resolution cameras positioned strategically around the playing area. These cameras will capture the shooting action from multiple angles, ensuring comprehensive coverage of the player's movements.

**b.** Motion Sensors: Integrated motion sensors will be attached to the player or incorporated within the equipment itself. These sensors will detect and record the player's body position, movement, and shooting technique with exceptional accuracy.

**c.** Shooting Angle Analysis: The algorithms will precisely calculate shooting angles by combining information from the cameras and motion sensors. The system will account for various factors such as release point, shooting arc, and body positioning to determine the exact angles at which shots are taken.

#### References

Bobrowsky (2019).Humble Free Throw Retrieved from https://www.swish22.com/blog/2014/10/14/humble-free-throw-why-so-misunderstood-and-mis-performed

Boyd, Natalie (2021).Explanation of non-significance Retrieved from https://study.com/academy/lesson/interpreting-a-non-significant-outcome.html?fbclid=IwAR1TAfdXzd\_xkUGQB2zyUfw3YdxtWfjeZttRl6OaePTfmntdeCqPQHtnfWE -:~:text=Non%2Dsignificance%20in%20statistics%20means,is%20not%20due%20to%20chance

Cabarkapa, D., Fry, A., Carlson, K., Poggio, J., & Deane, M. (2001).Key Kinematic Components for Optimal Basketball Free-Throw Shooting Performance Retrieved from https://www.google.com/url?q=https%3A%2F%2Fpdfs.semanticscholar.org%2Ff8cc%2F3a170fddfea0dae543e01dc3db62f3113240. pdf&sa=U&ved=2ahUKEwilg9a08M7\_AhUb-DgGHTiIDYMQFnoECAoQAg&usg=AOvVaw0BI8nw9xBHhd6fi9pbOeg

Conversation, L. S. (2019b, March 15). The Math Behind the Perfect Free Throw Smithsonian Magazine. https://www.smithsonianmag.com/innovation/math-behind-perfect-free-throw-180968313/

Decathlon.(2019). Badminton Footwork and Position on the Court | Decathlon. blog.decathlon.in. https://blog.decathlon.in/articles/badminton-footwork-and-position-on-the-court

Di Maria, Giovanni (2022). The Laws of Physics in Basketball Retrieved from https://ww.eetimes.eu/the-laws-of-physicsinbasketball/#:~:text=When%20a%20basketball%20player%20throws,angle%20and%20imparting%20greater%20force

Johnny (2023). The Best Angle to Score a Soccer Goal: From the Top of the 18-Yard Box Retrieved from https://www.google.com/url?sa=t&source=web&rct=j&url=https://clubleonen.com/the-best-angle-to-score-a-soccer-goal-from-the-top-of-the-18-yard-box/&ved=2ahUKEwjx7-nT-

tL\_AhVmd2wGHQ2CDwQQFnoECAwQAQ&usg=AOvVaw3BK2j\_SfSxOp\_LAo8CZV6\_

Khan, Athar Khan (2019). Calculation and interpretation of Mean and Median Retrieved from https://www.google.com/url?sa=t&source=web&rct=j&url=https://www.toppr.com/bytes/calculation-and-interpretation-of-mean-and-

median/%23:~:text%3DThe%2520mean%2520is%2520the%2520sum,the%2520mean%2520or%2520average%2520score.&ved=2a hUKEwibq53T7NH\_AhWgRWwGHS3\_BnIQFnoECA4QBQ&usg=AOvVaw2M5yZVrHGvc0cOcV-L4QS4

Metro League.(2022c, July 23).Metro League - A place of Sport Outdoor and Adventure.

Bulahan et al.

 $\odot$ 

https://www.metroleague.org/?fbclid=IwAR0\_5XnZCJma2-5Q3-SAZ2zubKLtcf1-UkNCH\_nbGvT-QorG6tcbnIYwo-I

Nor-Al-Din, S. M. B., Shamsuddin, N. a. A., Khairiah, R. N., & Sukri, N. B. M. (2021b). Analysing an Optimal Angle in Basketball Free Throw. Journal of Physics: Conference Series, 2084(1), 012017. https://doi.org/10.1088/1742-6596/2084/1/012017

Nordland, T., (2019) Humble Free Throw - Why So Misunderstood and Mis-Performed? — Swish International. Swish International https://www.swish22.com/blog/2014/10/14/humble-free-throw-why-so-misunderstood-and-mis-performed

Olteanu, M., Oancea, B. M., & Badau, D. (2023). Improving Effectiveness of Basketball Free Throws through the Implementation of Technologies in the Technical Training Process Retrieved from https://www.mdpi.com/2076-3417/13/4/2650

Pakosz, P., Domaszewski, P., Konieczny, M., & Bączkowicz, D.,(2021). Muscle activation time and free-throw effectiveness in basketball. Scientific Reports, 11(1).https://doi.org/10.1038/s41598-021-87001-8

Pritha Bandari (2022). Variability/Calculating Range, IQR, Variance, Standard Deviation Retrieve from https://www.google.com/url?q=https://www.scribbr.com/statistics/variability/&sa=U&ved=2ahUKEwiG5dTi8NL\_AhXzcGwGHbkS Dz4QFnoECAgQFA&usg=AOvVaw1XNgo9n5UZ5rrzikQ4v7Ov

Redirect Notice. (n.d.-c). https://www.google.com/url?q=https://corporatefinanceinstitute.com/resources/data-service/mean/&sa=U&ved=2ahUKEwjJ7sy97sbAhW7aGwGHWzPBokQFnoECAEQAg&usg=AOvVaw22k-cx91aK6lkAoeC\_0YO

Ricky Liuzhou (2023) Why the Angle of Release Important in Badminton Retrieved from https://www.metroleague.org/?fbclid=IwAR0\_5XnZCJma2-5Q3-SAZ2zubKLtcf1-UkNCH\_nbGvT-QorG6tcbnIYwo-I

Third Space Learning.(2023b, June 8). What is mean In Math? Examples & Questions For Primary School. https://www.google.com/url?q=https://thirdspacelearning.com/us/blog/whatismeanaverage/&sa=U&ved=2ahUKwio39i0cb\_AhUHR 2wGHbCsBEgQFnoECA0QBg&usg=AOvVaw3jhwEOFJptEWyn6dnhqsGz

Weldon, A., Mak, J. C. C., Wong, S. W., Duncan, M. J., Clarke, N. D., & Bishop, C. (2021). Strength and Conditioning Practices and Perspectives of Volleyball Coaches and Players. Sports, 9(2), 28. https://doi.org/10.3390/sports9020028

#### **Affiliations and Corresponding Information**

Madel S. Bulahan Kabankalan Catholic College – Philippines

**Ralph Chister L. Balongcas** Kabankalan Catholic College – Philippines

**Christian I. Almero** Kabankalan Catholic College – Philippines

Midylin B. Erodias Kabankalan Catholic College – Philippines

**Jirah Grace Tondo** Kabankalan Catholic College – Philippines

**Dr. Milagros Aurea A. Sabidalas** Kabankalan Catholic College – Philippines

Mary Grace G. De La Cruz

Department of Education Schools Division of Negros Occidental – Philippines