International Journal of Sociologies and Anthropologies Science Reviews (IJSASR), 3 (6), November-December 2023, pages 413-424. Old ISSN 2774-0366: New ISSN 2985-2730
Website: https://so07.tci-thaijo.org/index.php/IJSASR/index
DOI: https://doi.org/10.60027/ijsasr.2023.3686

Effect of Imagery Training on College Students' Basketball Shooting Accuracy

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Received 05/10/2023 Revised 08/10/2023 Accepted 20/10/2023

Abstract

Background and Aim: The difficulty in basketball shooting predominantly arises from a lack of adequate physical abilities, incomplete skill development, and a shortage of appropriate training. The objective of this research was to integrate meditation training and imagery training into the shooting training of the college men's basketball team at Xi'an Aviation College.

Materials and Methods: In this research, the questionnaire survey method and experimental method were used. Three experts were invited to rate the shooting performance of 40 of China's college basketball players, divided into 20 each in the experimental and control groups. In the experiment, the students' imaginative ability, self-confidence in shooting status, and scores of shooting performance were tested in the 1st, 4th, and 8th weeks, respectively, and then the results were compared and analyzed by T-test.

Results: After 8 weeks of training, the technical movements and shooting hit rate of the experimental group were significantly higher than that of the control group; the performance of the experimental group and the control group both improved after the experiment, but the experimental group had a significant increase in shooting performance, imagination ability, and shooting status self-confidence, while the control group only had a significant increase in the total score of shooting performance.

Conclusion: College students' shooting scores are affected by a variety of factors, and each student's learning needs and strengths are different, so the teaching program needs to be flexibly adapted to suit the needs of different students. These results showed that the integration of meditation training and imagery training can significantly improve college students' shooting performance more than traditional shooting training, as well as improve students' imagery ability and shooting self-confidence, which in turn improves the quality of shooting training.

Keywords: Meditation Training; Imagery Training; Shooting Confidence; Shooting Accuracy

Introduction

Basketball, a globally engaging sport, has seen substantial growth, particularly among the youth. The sport demands holistic body development and the mastery of diverse positions from its players. The adoption of sports science principles is essential for improved training, strategizing, and post-game advancements. Basketball's prominence is evident in annual competitions ranging from school events to the Olympics, and its influence extends globally, reaching continents and countries like Africa, North America, South America, India, Japan, Spain, Germany, Brazil, and America. (Okazaki et al., 2015) Basketball proficiency hinges on mastering skills like dribbling, passing, and especially shooting. Systematic training, incorporating sports psychology principles like mental imagery, is essential for competition preparation. This mental resilience helps athletes overcome stress and anxiety, enhancing their physical performance. Okazaki et al. (2015) emphasize the role of psychological training in performance improvement. For top-tier athletes, shooting skills are crucial. Skill development relies on psychological training principles and sports imagery training methods. Using these techniques, athletes can manage stress, anticipate gameplay scenarios, and foster a dynamic playing style, as highlighted by Wang Y (2014). Basketball shooting often creates challenges due to inadequate physical performance and skills training. Shot execution hesitance due to a perceived lack of expertise often leads to less effective competitive performance. An analysis of player performance during competition, specifically for complicated shots like jump shots, penalty shots, and layups, is key. Mental imagery, or creating mental pictures that stimulate experiential learning, can help athletes control emotions, regulate anxiety, enhance concentration, and improve overall performance according to Petterson, H., & Olson, B.L. (2016). This concept aligns with a study on PETTLEP imagery training, which successfully improved

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participants' throwing and receiving skills (Vogt et al., 2013). Our study of basketball shooting thus involved a comprehensive literature review and consultation with imagery training experts. By utilizing mental imagery principles, we aim to help basketball athletes improve goal-scoring efficiently and significantly.

Objectives

1. To study the effects of basketball shooting training and imagery training on shooting accuracy.
2. To develop a training model that combines imagery training and shooting training.

Literature Review

1. Imagery training

Imagery training is a psychological strategy used in sports and physical education. Wang Lei (2020) study found that episodic training improved freestyle swimming techniques in adolescents, emphasizing the importance of individual differences. Zhang Wei (2019) showed that Imagery training improved hip-hop performance in music students. Fu Haoyue (2018) found that imagery training improved volleyball skills and reduced forgetfulness. Zhao Weiran (2020) study highlighted the importance of individual differences in Imagery training for standing long jump skills in junior high school students. However, extroverted personality traits had a greater effect on the training method than introverted traits.

Several studies have examined the effects of motor imagery training on various outcomes. Fekih and Sallemi et al. (2020) found that motor imagery could mitigate the negative effects of Ramadan on tennis performance. Ota T and Sato et al. (2020) showed that motor imagery training combined with neurofeedback could improve hand dexterity and increase brain activity. Malouin and Richards et al. (2016) found that post-stroke patients improved their motor performance with this type of training. Rodríguez et al. discovered that imagery training could reduce the fear of reinjury and pain in athletes. Bertollo et al. (2016) found that a mental training program, including relaxation, imagery, and concentration, could improve basketball performance under pressure. Hidayat Y. (2021) successfully used an education and training program to improve badminton coaches' knowledge, attitude, and skill in integrating mental imagery into training. Hiskey and Clapton (2021) suggested a protocol for dynamic imagery interventions for martial artists to cope with stressful events. Rhodes and May proposed a method aimed at increasing short- and long-term motivation through imagery by setting beliefs, values, and purposeful long-term goals, contrasting current and future selves, and planning for immediate action.

2. Meditation training

Several studies have shown that meditation training can have positive effects on athletes' mental and physical well-being. Wang Bin and Luo Lili (2002) found that meditation training can reduce negative factors and increase positive factors in athletes' state of mind, reduce anxiety, heart rate, blood lactate, and fatigue, and improve self-confidence. Jiang Zhenying (2000) also found that meditation training can lower heart rate and reduce fatigue, depression, and anger. Song Yu and Zhang Weili (2020) found that positive thinking training can improve athletes' performance under pressure and produce positive psychological benefits.

Phil Jackson, a famous NBA Coach often employed an exercise that improved the performance and mood of the Los Angeles Lakers, leading them to consecutive league championships from 2000 to 2002, these exercises had calming and mood-enhancing effects, echoing similar findings reported by Ji L. and Yin H. C (2000). who carried out an 8-week positive thinking meditation training study. They observed significant improvement in participants' anxiety and inhibition scores and a substantial reduction in their Stroop task reaction time. Josefsson T et al. (2012) also explored this concept in a study involving 69 inexperienced elite athletes. Results showed improved emotion regulation and concentration indirectly affecting athletic performance. The athletes in the mindfulness-acceptance-commitment (MAC) group demonstrated significant improvements compared to the Psychological

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Skills Training (PST) group pointing out the efficacy of positive thinking. Reinforcing the benefits of positive thinking, a study by Jui-Ti Nien et al. (2020) also reported an increase in executive function and neutral emotional experiences among college athletes post a five-week positive thinking meditation intervention. Petterson, H., & Olson, B.L. (2016) echoed these results, indicating reduced stress perceptions and improved negative emotion management in student-athletes post a positive thinking training.

Moreover, a comparison study by Müller, C., et al. (2021) found that positive thinking training significantly improved participants' attention and executive functioning, including inhibitory control, compared with physical activity alone. Conclusively, positive thinking training has proven beneficial in improving attention and executive functioning, validating its widespread application in sports psychology and cognitive neuroscience.

3. Basketball shooting accuracy

Several studies have investigated how strength training and core strength can improve basketball shooting accuracy. Yang Yichen (2009) found that strength training can increase the shooting accuracy of jump shots. Song Xufeng and Zhao Huanbin (2009) suggested that core strength is crucial for successful shooting when physical qualities differ widely among players. Li You (2012) added that good physical fitness and technical ability are necessary for performing actions like the jump shot. He further explained the sequential exertion from the feet to the fingers during a throw. Lastly, Qian Xiaoyan and Xue Haihong (2011) emphasized the importance of core strength training for maintaining stability during shooting. These studies collectively suggest that strength training, core strength, and practical shooting training play significant roles in refining a player's shooting skill. Liu Yulin (2008) pointed out that the correct technical movement of shooting is the key to ensuring the shooting percentage. Through the formal basketball shooting action teaching video can be seen: ready to shoot, the practitioner's body toward the basket, the left and right feet open about 1.2 times the width of the shoulder, the right foot is slightly in front of the left foot, the right hand five fingers open holding the ball, the left hand as an auxiliary to put the ball on the side of the knee slightly curved.

Several studies have demonstrated the impact of enhanced motor function on improving shooting accuracy in basketball, such as Sava, L.S., et al. (2018) used targeted explosive movement training to increase players' motor functional capacity. After an eight-week intervention, it was found that the athletes' shooting accuracy significantly improved. Okubo and Hubbard (2016) highlighted that manipulating hand, forearm, and upper arm movements could achieve better ball velocity, angle, and rotation. This approach was more efficient than shooting with the hand alone but needed players to control the angular velocity and acceleration of each body joint stably. In a related study, Okubo and Hubbard (2016) discovered that increasing the shooting distance required greater power, lower limb strength, and shoulder joint flexibility. Also, applying multiple angular displacements and speeds at wrist, elbow, and shoulder joints helped achieve optimal ball release speed and angle, consequently improving shooting efficiency. Verhoeven F M (2016) et al.'s research further underlined the importance of postural stability and coordination during basketball free throws. Results showed that improvements in these areas contributed to increased skill levels and better results in free throw attempts. Thus, overall motor function improvement contributes to a higher shooting success rate.

Conceptual Framework

The conceptual framework for this research is as follows:

The independent variable is the basketball shooting program combined with imaginary training.

The dependent variable is the results of shooting accuracy of male basketball shooting.

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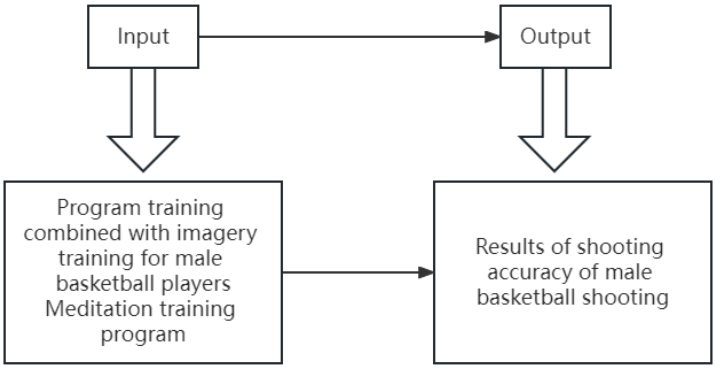

Figure 1. Research Conceptual Framework

Methodology

Population and sample

Population: Demographics The population is 45 China's university students, aged between 18-22 years, height 180-190 cm., weight between 75-85 kg.

Sample: Through the systematic sampling method, 40 of China's university students were selected as a sample group. In this research, systematic sampling testing the shooting accuracy of male basketball players according to the training of Zhang Jang (2011) was used sampling, followed by sorting the scores from highest to lowest, then eliminating the middle group of 5 people, and putting them into 2 in specific groups, 2 equal groups. Then the numbers were drawn and divided into 2 groups: an experimental group of 20 people would practice shooting basketball goals along with training with imagery, and a control group of 20 people would practice shooting goals with values.

Experimental design

The researcher designed an 8-week experiment to compare the results of the experiments and then analyzed the data using repeated-measures analysis of variance using the training and testing formats as shown in the following figure.

	Q_1							Q_2
Control		**S**	**S**	**S**	**S**	**S**	**S**	**S**
Week		1	2	3	4	5	6	7	8

	Q_1							Q_2
Experimental		**X+S**	**X+S**	**X+S**	**X+S**	**X+S**	**X+S**	**X+S**	**X+S**
Week		1	2	3	4	5	6	7	8

Q_1 refers to data collection before shooting practice.
Q_2 refers to data collection after week 8.
S refers to the normal shooting style.
X+ S refers to the form of imaginary training combined with basketball shooting

Research tools

1. Imagery exercises combined with basketball goal-shooting exercises.
2. Basketball shooting test for accuracy Zhang Jang (2011) by dividing the scoring of basketball goals into 1-5 points.

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3. Basketball shooting training programs. This training program will include basic movement training, spot shooting, shooting in motion, practice shooting from different angles and positions by using the rim, hook shot practice, free throw practice, pressure shooting, and shooting competition.
4. Software package for analysis.
5. Models of basketball operations according to the model guidelines.

Collecting data process

The first divided the sample into 2 groups, namely the experimental group and the control group, each with 20 people. Second, before starting to practice basketball shooting, both the control group and the experimental group conducted the pre-test. After 8 weeks of training, the control group and the experimental group conducted the post-test. Lastly, the results of the pre-test and post-test of the two groups were analyzed and compared.

Data Analysis

The results of the test before and after the practice of shooting a goal with imagery will be measured in weeks 1 and week 8. The experimental group and the control groups used the following mindfulness exercises.

1. Find the mean ($\bar{x}$) and standard deviation (S.D.) of the test results of shooting training combined with mental imagery training between the control group and the experimental group.
2. Compare differences in means using t-test statistics with significance.

Results

1. Shooting test with imagery

The training model combining basketball shooting training and imagery training was obtained through a survey of related literature and discussions among five basketball teachers and coaches, and the model diagram is as follows:

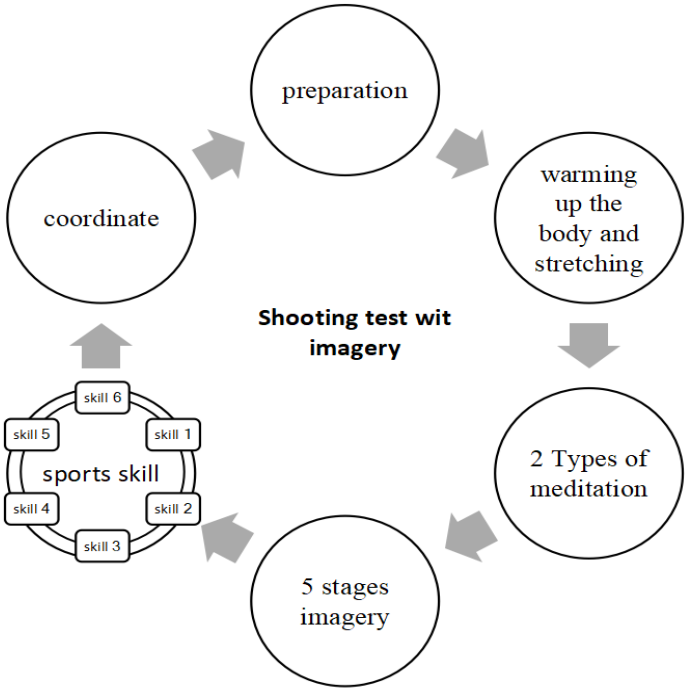

Figure 2. Shooting test with imagery

2. IOC inspection specialist

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Five experts were invited to conduct the IOC of the questionnaire. According to the IOC statistics, there are 8 items in the Representational Ability Questionnaire, and the IOC indexes of all items are greater than or equal to 0.8, IOC value = 0.98.

There are 9 items in the shooting status confidence Questionnaire, and the IOC indexes of all items are greater than or equal to 0.8, IOC value = 0.98.

The results show that the consistency of the objectives of the questionnaire items is relatively high, and the questionnaire' setup is effective.

3. Results of the experiment

3.1 Descriptive statistical analysis of the sample and an overview of the pretest shot performance data

Table 1 List of subjects' basic information

Project	Exp. group	Con. group	t	Sig.
Height (cm)	185.41±4.59	185.50±4.50	-0.192	0.697
Weight (kg)	84.04±7.59	84.51±7.46	-0.088	0.209
Age	20±2	20±2	0.173	0.958
number	20	20	—	—

Table 2 Comparative analysis of imagery ability and shooting status confidence between experimental and control groups before the experiment (N=20)

Project	Exp. group	Con. group	t	Sig.
Imagery ability	23.72±3.55	24.41±4.01	-1.165	0.697
Shooting status confidence	27.53±4.55	28.65±4.49	-0.542	0.601

Table 1 and Table 2 can be seen in the experimental group and the control group of students in the age, height, weight, the data of imagery ability to compare and analyze the test scores of the two groups of students found to be at the same level, after the test ($p>0.05$), indicating that the physical conditions of the two groups of students, the ability to imagine and shooting performance is at the same level, there is no significant difference, to ensure the feasibility of the experiment.

Table 3 Comparative scores of three shooting performances before the experiment (N=20)

Group skill (N = 20)	Con. group		Exp. group		t	Sig.
	$\bar{x}$	S.D.	$\bar{x}$	S.D.		
Penalty	28.64	2.82	28.13	2.81	-0.192	0.249
Lay up	29.51	2.96	29.04	2.94	-0.088	0.232
Jump	27.27	2.71	27.33	2.72	0.173	0.242

A basketball skills test was conducted before the experiment according to the technical standards of basketball shooting movements, and the results showed that the experimental group was similar to the control group in Penalty, Layup, and Jump scores; there was no difference in the scores of shooting performance in the three skills tests. The paired samples t-test showed that there was no significant difference between the experimental group and the control group ($p>0.05$), and the skills of the two groups of students were at the same level.

3.2 Analysis of the results of the experiment in week 8

After the experiment was carried out to the end of the eighth week of the experimental group and the control group shooting performance test, and the test results were input into the SPSS26.0 and EXCEL software for analysis, using the paired samples t-test, the results are shown in Table 12, from which it can be seen that the experimental group and the control group before the experiment in the five

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items of the shooting performance in the standing position and holding the ball, the ball-led action, the shot movement, follow the action, and the accuracy of hit The interim situation of performance.

1) Comparative experimental group and control group students' imagery ability and shooting state confidence after the experiment

Table 4 Comparative experimental and control group's Imagery ability and shooting status confidence after the experiment (N=20)

Project	Exp. group	Con. group	t	Sig.
Imagery ability	37.21±2.11	25.25±4.53	8.236	0.000***
Shooting status confidence	40.23±3.22	37.24±4.65	2.843	0.019*

*p<0.05, ***p<0.001

Table 4 shows that in the experiment, the experimental group scored significantly higher than the control group in terms of imagery ability, and the difference was statistically significant (p<0.001), and the experimental group also scored significantly higher than the control group in terms of shooting confidence (p<0.05). Because the experimental group had imagery training and meditation training, while the control group did not have imagery training and meditation training, the experimental group's ability of episodic training and shooting confidence was significantly higher than that of the control group at the end of the fourth week. It shows that imagery training can improve the athletic imagery ability and shooting state confidence of college students.

2) Comparison of three shooting performance scores after the experiment

Table 5 Comparative the scores of the three shooting performances after the experiment (N=20)

Group skill (N = 20)	Con.		Exp.		t	Sig.
	$\bar{x}$	S.D.	$\bar{x}$	S.D.		
Penalty	35.67	0.82	45.25	0.56	9.114	0.007**
Lay up	35.67	0.81	45.33	0.36	9.656	0.006**
Jump	35.16	0.36	45.21	0.75	9.216	0.004**

**p<0.01

Table 5 shows that the shooting performance scores of the shooting performance experimental group on all three movements of Penalty, lay and Jump are significantly higher than those of the control group (p<0.01), which indicates that general basketball training has extremely significant enhancement effects on the shooting performance of college students on the three movements of Penalty, lay up and Jump with the addition of imagery training and meditation training experiments.

3) Comparative analysis of the scores of three shooting maneuvers of the experimental group

Table 6 Comparative the scores of the three shooting performances after the experiment and before the experiment (Experimental group)

Group skill (N = 20)	Q2		Q1		t	Sig.
	$\bar{x}$	S.D.	$\bar{x}$	S.D.		
Penalty	45.25	0.56	28.13	0.16	10.356	0.000***
Lay up	45.33	0.36	29.04	1.23	10.307	0.000***
Jump	45.21	0.75	27.33	1.12	10.217	0.000***

***p<0.001

By comparing the shooting performance scores of the control group after the experiment with those before the experiment, it was found that the shooting performance scores on Penalty, Layup, and Jump were significantly higher than those at the initial stage (p<0.001), which indicated that the

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performance of the control group on all three shooting modes was improved to a very large extent after the experiment.

4) Comparative imagery ability and confidence in shooting status after the experiment and before the experiment in the experimental group

Table 7 Comparative analysis of the post-experimental and pre-experimental imagery ability and shooting status confidence (experimental group, N=20)

Project	Q2	Q1	t	Sig.
Imagery ability	37.21±2.11	23.72±3.55	13.162	0.000***
Shooting status confidence	40.23±3.22	27.53±4.55	12.536	0.000***

***p<0.001

Table 7 shows that the experimental group students' scores on imagery ability and shooting state confidence after the experiment were higher than those before the experiment, and there was a statistically significant difference (P<0.001). Because the experimental group carried out imagery training and meditation training, while the control group did not carry out imagery training and meditation training, but only general shooting movement training, the experimental group at the end of the eighth week of the imagery training ability is significantly higher than before the experiment. It shows that the effect of this episodic training combined with meditation training can significantly improve the college students' imagery ability and college students' shooting state confidence is not significant.

5) Comparative imagery ability and shooting status confidence after the experiment and before the experiment in the control group

Table 8 Comparative imagery ability and confidence in shooting form (control group, N=20)

Project	Q2	Q1	t	Sig.
Imagery ability	25.25±4.53	24.41±4.12	0.578	0.021
Shooting status confidence	37.24±4.65	28.65±4.34	5.446	0.034*

*p<0.05

Table 8 shows that: the scores of the students in the control group after the experiment on the imagery ability are slightly higher than the scores before the experiment, but there is no statistically significant difference (p>0.05), the scores in the experiment on the confidence in the shooting state are significantly higher than the scores before the experiment and are statistically significant (p<0.05). Because the control group did not carry out imagery training, but only general shooting practice, the experimental group at the end of the 8th week the appearance of training ability did not improve, indicating that 8 weeks of general shooting training on college students' ability to represent and shooting state of self-confidence will have a significant effect.

6) Comparative analysis of the scores of the three shooting performances after and before the experiment

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Table 9 Comparative scores of the three shooting performances after and before the experiment (Control group, N=20)

Group skill (N = 20)	Q2		Q1		t	Sig.
	$\bar{x}$	S.D.	$\bar{x}$	S.D.		
Penalty	35.67	0.82	28.64	1.35	7.232	0.019*
Lay up	35.67	0.81	29.51	0.76	7.145	0.016*
Jump	35.16	0.36	27.27	0.64	8.237	0.004**

*p<0.05, **p<0.01

By comparing the shooting performance scores of the control group after the experiment with those before the experiment, it was found that the shooting performance scores on both Penalty and Lay up were higher than those at the initial stage ($p<0.05$); in terms of the score of Jump, the control group's performance was significantly improved after the experiment compared with that before the experiment, with a significant difference ($p<0.01$), which indicated that the control group's performance in the way of Jump shooting was also improved a improved to a certain extent.

Conclusion

1. Imagery training has a significant effect on the shooting rate of college men's basketball players. Compared with conventional basketball shooting training, basketball shooting training incorporating meditation training and imagery training can improve the shooting rate of college men's basketball players more significantly.

2. Imagery training has a significant effect on college men's basketball players' shooting confidence. Compared with conventional basketball shooting instruction, basketball shooting instruction incorporating meditation training and imagery training can significantly improve college men's shooting confidence.

3. Imagery training has a significant effect on the athletic imagery ability of college male basketball players. Compared with conventional basketball shooting instruction, basketball shooting instruction incorporating meditation training and imagery training can improve the overall athletic imagery ability of college male basketball players more significantly.

Discussion

1. Discussion on the influencing factors of shooting performance

College students' shooting performance is influenced by multiple factors, including technical aspects, physical functions, psychological aspects, and external variables. In the initial learning phases, learners often struggle with non-standard shooting postures, as they have not yet formed a clear conception of shooting action (Liu Yulin, 2008). Technical issues might include incomplete finger spread when holding the ball, excessive adduction of the elbow joint, and insufficient wrist movement.

Physical limitations such as height and strength may also affect performance, causing issues like inadequate lower limb force, uncoordinated limb exertion, low shooting arc, and lack of follow-through. Additionally, psychological factors such as weak mental strength, lack of confidence, poor rhythm sense, and discouragement from missed shots further hinder performance. emphasizes that correct technical shooting movements are pivotal for shooting accuracy. A standard basketball shooting action involves positioning the body towards the basket, with feet shoulder-width apart, and the right foot slightly forward. The ball is held with the right hand's open fingers, while the left hand assists. The shooting action starts with a knee-bend and force applied from the toes upwards, transitioning from the waist and abdomen to the shoulders and then to the upper limbs. The follow-through motion should coincide with the ball's direction.

2. Meditation Training and imagery training Significantly Improve College Boys' Shooting Accuracy

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International Journal of Sociologies and Anthropologies Science Reviews (IJSASR), 3 (6), November-December 2023, pages 413-424. Old ISSN 2774-0366: New ISSN 2985-2730
Website: https://so07.tci-thaijo.org/index.php/IJSASR/index
DOI: https://doi.org/10.60027/ijsasr.2023.3686

Following an 8-week training period, it was observed in this study that college males' shooting accuracy significantly improved due to imagery training, which also prevented the degradation of shooting skill development. The experimental group showed a longer shooting motion, better overall joint and muscle coordination, improved shooting rhythm, and more precise regulation of shooting motion than the control group.

This observation aligns with Zhang Guoli's (2014) studies, which reported an enhanced shooting hit rate through strengthening visualization of wrist movements during basketball shooting. These studies endorse the specialized cognitive function of imagery ordination in enhancing specific perceptual-motor skills. They suggested that imagery training improved the proprioception of the practitioners' wrist and elbow joints, thereby enhancing shooting accuracy. Emphasizing intensive training of detailed shooting movements, particularly wrist and finger-pointing shooting, can improve the perceptual-motor skills of college males, coined as the "ball sense".

The study further revealed that in the early stage of shooting motion teaching, verbal and video feedback alongside external imagery facilitated the learning of shooting skills. As the experiment progressed, students in the experimental group actively visualized and independently conducted shooting training before shooting, resulting in a significant increase in the shooting hit rate. Hence, integrating imagery training with physical education teaching is effective in improving students' shooting skills, fortifying basketball skills, enhancing motor skill learning, and solidifying sports skill levels 3.

3. The effects of meditation training and imagery training on college students' shooting state confidence

The theory of mental skill training suggests that imagery training influences behavior by developing or strengthening mental skills. After 8 weeks of meditation and imagery training, observations revealed that the experimental group exhibited more coordination and relaxation in completing shooting movements compared to the control group. Data analysis indicated a higher state of confidence in shooting among students in the experimental group. Hence, this study concludes that imagery training enhances college male students' state confidence.

It's been observed that meditation and imagery training stimulate athletic potential and increase motivation, thereby enhancing state confidence in athletic competition. Moreover, studying images of a textbook's shooting action decomposition and viewing videos of NBA athletes' shooting techniques positively impacts students' understanding of the shooting action and motivates them to improve.

This study also found that creating corresponding situations is an effective way to enhance learners' confidence. Guided by the dimensions of motivational arousal of imagery stimulation, negative factors in training can be transformed into positive ones, facilitating psychological activation. Therefore, providing vivid instructions for each shooting action segment and presenting specific shooting scenarios allow students to train without stress, converting anxiety into confidence, thereby enhancing shooting state confidence.

Recommendation

1. Should add more variety to the goal-scoring skill program.
2. Shooting training should be combined with imagery training that can be researched with other sports that have similar characteristics to basketball.
3. Methods for selecting sample groups in data studies should be added to result in efficient data analysis that can be used in future opportunities.
4. The training model that combines the imagery training and shooting training of this study is promoted on the software of Jitterbug, Xiaohongshu, and Shutterbug video.

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