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The Effect of Thinking Styles on Volleyball Serve Learning in Adolescent Female Students Based on Sternberg's Model

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A B S T R A C T

The role of thinking styles in learning psycho-motor skills, such as volleyball serve, is rarely investigated in female volleyball players. This study was an attempt to fill this gap. This quasi-experimental study with a pretest-posttest approach aimed at investigating the effect of thinking styles, based on Sternberg's model, on volleyball serve learning in female adolescent students. To determine the sample size, G*Power v3.1 was used (α = 0.05, power = 0.95, and number of parameters = 3), and 45 female students (average age = 16.5, SD = 0.85) who met the inclusion criteria were selected through convenience sampling from one of secondary schools in Nasiriyah, Iraq. Based on the their thinking styles, after administering the Thinking Style Inventory - Short Version, they were divided into three 15-member groups, i.e., Type I, Type II, and Type III. They took AAHPERD Volleyball Skills Test as the pretest, and as the acquisition, retention and transfer tests. The training program lasted for 12 weeks, 3 sessions per week, and each session for 60 minutes in accordance with the pre-determined protocols and guidelines of AAHPERD test. The data were analyzed using a mixed ANOVA. There was a significant difference in volleyball serve learning between the groups, with Type I outperforming Type III, while no significant difference was detected between Type I and Type II, or between Type II and Type III. In teaching and evaluating psycho-motor skills, enough attention should be paid to thinking styles, as it can help teachers to employ a variety of methods in this regard. The variety and flexibility they create by taking into account the students' thinking styles determine whether and to what extent they succeed in the teaching process.

Keywords: *thinking styles, Sternberg, learning, volleyball serve, female students.*

1. Introduction

The ability to learn is vital for a living being since it enables an organism to adapt itself to environment. The survival of any living being requires that it behaves in such a way as to be compatible with the environment, and such compatibility requires the ability to learn. Humans differ in the way they learn things, which are reflected in their abilities, talents, desires, and thinking styles, and when such differences are respected, they will have better chances to succeed in their career. Learning is defined as "all behavioral changes that come about as a result of experience. Such changes include not only the acquisition of new information, but also changes in behavior whose causes are unknown" (1). Many scholars maintain that thinking styles affect learning (1-3).

Sternberg (2) presented a theory on thinking styles – mental self-government – which is based on the principle that the type and form of government that we have in the world is not accidental, but rather an external reflection of thoughts that exist in people's minds. This theory (2) describes 13 thinking styles that are distinguished from each other in five dimensions including: Functions (i.e., legislative, executive and judicial), Levels (i.e., global, and local), Forms (i.e., hierarchical, oligarchic, monarchic, and anarchic), Domains (i.e., internal, and external), and Tendencies (i.e., liberal, and conservative). These 13 thinking styles can be classified into three types of styles, as follow:

- Type I (creativity-generating): It is composed of thinking styles that are more creativity-generating and that denote higher levels of cognitive complexity (i.e., legislative, judicial, hierarchical, global, and liberal).
- Type II (norm-favoring): It consists of thinking styles that suggest a norm-favoring tendency and denote lower levels of cognitive complexity (i.e., executive, local, monarchic, and conservative).
- Type III (task-based): It consists of anarchic, oligarchic, internal and external thinking styles; it may manifest the characteristics of Type I and Type II styles, depending on the stylistics demands of specific task.

In the context of sports, the use of Sternberg's model can facilitate the development of athletes' skills and decision-making processes. The combination of analytical, creative, and practical intelligences enables coaches and trainers to design training regimens that meet the diverse needs of athletes (4). For example, developing analytical intelligence helps athletes understand game strategies, while developing practical intelligence helps them improve their performance through practical experiences. Furthermore, understanding the interaction of these intelligences allows for a more comprehensive approach to athlete development, emphasizing not only skill development but also personal growth and teamwork for performing complex physical movements (4); this highlights the necessity of effective cognitive functioning. The studies indicated that the cognitive processes involved in decision-making, multitasking and concentration are critical for athletes to excel in their sport. For instance, in fast-paced team sports such as volleyball, athletes must make quick decisions while simultaneously performing complex physical movements.

The cognitive aspects of sports performance can be further explored through Sternberg's Triarchic Theory of Intelligence, which outlines how different types of thinking styles contribute to athletic skills. For example, analytical thinking enables athletes to solve complex problems and make strategic decisions during competitions. Meanwhile, creative thinking allows athletes to innovate, adapt their techniques, and increase their overall performance. The interaction of these cognitive components is essential for developing effective strategies that enhance athletic skills and sports performance. By identifying the dynamics of thinking styles and cognitive processing in sports, researchers can support further studies that aim at testing the effectiveness of cognitive interventions in the case of athletes (5).

Particularly in volleyball, understanding the thinking styles requires consideration of different cognitive frameworks, such as the Cognitive-Affective Personality System (CAPS), which shows how personal beliefs, emotional responses and cognitive strategies interact to influence performance outcomes (6). Also, studies have shown that players who use appropriate cognitive strategies – such as goal setting, visualization and self-talk – based on their specific thinking styles achieve greater success during practice and competition (7).

The absence or lack of research on thinking styles is considered one of the basic problems in this field (8). After Sternberg's theory (2), many studies were conducted in this regard (9-12), indicating the positive effects of paying attention to thinking styles on promoted performance in various sports. Zhang et al. (13) found that creation of commitment, identification of commitment, and career flexibility require creativity-generating and norm-favoring thinking styles, and that creativity-generating styles opposed career self-doubt, while norm-favoring style contributed to it. Fattah et al. (14) found that female students with liberal thinking style enjoy mental preparation, mental motivation and performing serve skills, and those with conservative thinking style have weakness in this regard. Eraslan (15) found that men use thinking styles significantly more, and

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that fields of study significantly differentiate athletes in employing thinking styles.

Based on the review of the related literature, it seems that the effect of thinking styles on sport skills has been rarely studied; particularly, in the field of volleyball and female adolescent athletes, few studies can be found that deals with the role of thinking styles in promoting the psycho-motor skill performance. This study sought to fill this gap and answer these questions:

RQ1: To what extent do thinking styles affect volleyball serve learning?

RQ2: Is there any significant difference between thinking styles in volleyball serve learning?

2. Methods and Materials

2.1. Study Design and Participants

This is an applied quasi-experimental study with pretest-posttest approach and three experimental groups. The population included female secondary school students. To ensure the required sample size, G*Power software was used ($\alpha = 0.05$, power = 0.95, and number of parameters = 3). The sample consisted of 45 female students (average age = 16.5, and SD = 0.85) selected through convenience sampling from one of the secondary schools in Nasiriyah, Iraq – *Baghdad Secondary School*. The participants, based on the results of the *Thinking Style Inventory* developed by Sternberg and Wagner (3) and validated and factor-analyzed by Alborzi and Ostovar (16), were divided into three groups (i.e., Type I, Type II, and Type III) with equally 15 students in each group.

2.2. Instruments

2.2.1. Thinking Style Inventory – Short Version

To determine the thinking styles of the participants, the *Thinking Style Inventory – Short Version* was adopted (16). It includes 65 items and 13 subscales (5 items each) corresponding to 13 thinking styles – legislative, executive, judicial, global, local, hierarchical, oligarchic, monarchic, anarchic, internal, external, liberal and conservative. In case of each item, the respondent is supposed to rate him/herself on a seven-point scale ranging from 1 (i.e., the item does not describe me at all) to 7 (i.e., the item describes me very well). As stated earlier, these 13 thinking styles constitute three factors, i.e., creativity-generating (Type I), norm-favoring (Type II), and the third factor (Type III). According to Alborzi and Ostovar (16), these three factors accounted for 61.7% of the total variance explained, and that the correlations between the thinking styles were in line with Sternberg's theory (2, 3), indicating the validity of the constructs. The reliability of this inventory was also estimated through Cronbach's alpha, and was reported to be from 0.58 to 0.82 (16). It was reported that the results obtained were in consistency with those of Sternberg and Wagner's *Thinking Style Inventory – Long Version* (16).

2.2.2. AAHPERD Volleyball Skills Test

To evaluate the volleyball serve skill performance (in all stages of pretest, acquisition, retention, and transfer), AAHPERD test was used according to the instructions. This test assesses volleyball players' sports performance. The participants were supposed to stand in front of a marked field and perform ten correct and legal serves. These serves required the ball to pass over the net and land in the marked area. Balls that hit the net or landed outside the field were not awarded any points. The participants' scores were calculated based on the number of times the ball hit the opposite field. The scoring was as follows: 4 points were awarded for the end of the field, 3 points for the two side areas, and 1 and 2 points for the middle of the field. The final score for the subjects was determined by the sum of the points obtained from performing the serves ten times. Fig1 illustrates how the scoring was done.

Figure 1

Scoring Method for AAHPERD Volleyball Skills Test

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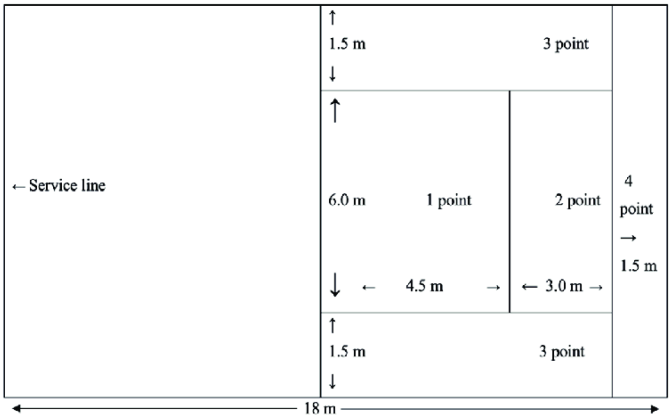

2.3. *Procedure, Data Collection and Data Analysis*

First, the researcher obtained the permission from the *Education Department* in Nasiriyah to conduct a study in one of the secondary schools. Then, one of the schools to which the researcher had good access, was chosen – *Baghdad Secondary School*. She coordinated with the school's principal and physical education teachers for attending the classrooms and carrying out the study. A researcher-made questionnaire was distributed among the students for collecting demographic information, and especially information about prior sport activity. After the questionnaires were responded, those students who met the inclusion criteria, i.e., (a) parental consent, (b) no motor impairment, (c) no cardiovascular problems, (d) no disorder (e.g., autism, Down Syndrome, and ADHD), and (e) no prior experience in motor skill of volleyball serve, were selected.

The students were informed about the study, and they – on a voluntarily basis – showed willingness to participate in the first phase of the study (i.e., determining the thinking styles). In this phase, the written consent was also obtained from the students, and they were assured that their information would be kept confidential. Then, the *Thinking Styles Inventory* (16) was administered. Based on the results obtained, 15 students from each of the three thinking styles (i.e., Types I, II, and III) were randomly selected. After identifying thinking styles and grouping the final 45 participants, and before the start of training program, the *AAHPERD Volleyball Skills Test* was administered as the pretest; it is worth mentioning that at the end of the training program, it was also conducted as the posttest to examine the levels of acquisition, retention, and transfer.

Then, the training program started, and the experimental groups were trained in volleyball serve skills according to the pre-determined protocols (17). The training program lasted for 12 weeks, three sessions per week, and each session for 60 minutes, including almost 10 minutes of warm-up, 45 minutes of main training, and 5 minutes of cool-down, as shown in Table 1.

Table 1

Descriptive Statistics of AAHPERD Volleyball Skills Test

Groups	Skill	Acquisition	Retention	Transfer
Types I, II, and III	Serve	The exercises were performed in 60 minutes in 10 blocks of 5 based on the AAHPERD Test.	After 48 hours, when the temporary effects of training were worn off, a retention test (similar to the acquisition test) was performed based on the AAHPERD Test.	After 72 hours, the transfer test was performed by varying the ball size and the height of balls sent, and the results were recorded.

As indicated in Table 1, after the training program was completed, the *AAHPERD Volleyball Skills Test* was administered as the acquisition test. After 48 hours from the last training session, the participants took the retention test,

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similar to the acquisition one. Finally, after 72 hours from the last training session, they took the transfer test in which the serve locations were changed (17).

For analyzing the data, SPSS v26 was used at the significance level of 0.05. The normality of data, the homogeneity of variances, and the sphericity, considered as the three major assumptions of mixed ANOVA, were examined by Shapiro-Wilk, Levene's, and Mauchly's tests, respectively. A mixed ANOVA with Tukey post hoc analysis was conducted to test the research questions.

3. Findings and Results

3.1. Assumptions

First, the data were probed for missing cases, outliers, and influential observations, and no violations were detected in this regard. To test the data for normal distribution, the Shapiro-Wilk test was run, the results of which showed that the scores obtained from the *AAHPERD Volleyball Skills Test* were normally distributed ($p > .05$) in the pretest, and the acquisition, retention and transfer tests, except for the scores of Type III Group in the transfer test ($p < .05$). Although the normal distribution was observed mostly in the dataset, it is worth mentioning that ANOVA is quite robust to violations of normality (18).

To see whether the variances of the three groups under study are equal regarding the scores obtained from *AAHPERD Volleyball Skills Test*, a Levene's test was run, the results of which indicated the groups have homogenous variances in the pretest ($F(2,42) = .13$, $p = .87$), in the acquisition test ($F(2,42) = 1.25$, $p = .29$), in the retention test ($F(2,42) = .64$, $p = .53$), and in the transfer test ($F(2,42) = 0.94$, $p = .39$). The results of Mauchly's test indicated there is violation of sphericity ($W = .19$, $X^2 = 66.65$, $p < .05$), therefore, the Greenhouse-Geisser correction was applied to avoid increasing the risk of Type I Error.

3.2. Descriptive Statistics

The descriptive statistics of the scores that the participants obtained from the *AAHPERD Volleyball Skills Test* in the pretest, acquisition, retention, and transfer stages are presented in Table 2 and Figure 2.

Table 2

Descriptive Statistics of AAHPERD Volleyball Skills Test

	Group	Mean	SD	N
Pretest	Type I	20.53	3.33	15
	Type II	19.87	3.46	15
	Type III	20.20	3.68	15
	Total	20.20	3.42	45
Acquisition Test	Type I	30.80	4.29	15
	Type II	27.80	3.55	15
	Type III	24.67	3.13	15
	Total	27.76	4.40	45
Retention Test	Type I	28.13	4.22	15
	Type II	25.40	4.01	15
	Type III	22.60	3.22	15
	Total	25.38	4.39	45
Transfer Test	Type I	27.93	4.44	15
	Type II	25.33	4.71	15
	Type III	22.73	2.98	15
	Total	25.33	4.56	45

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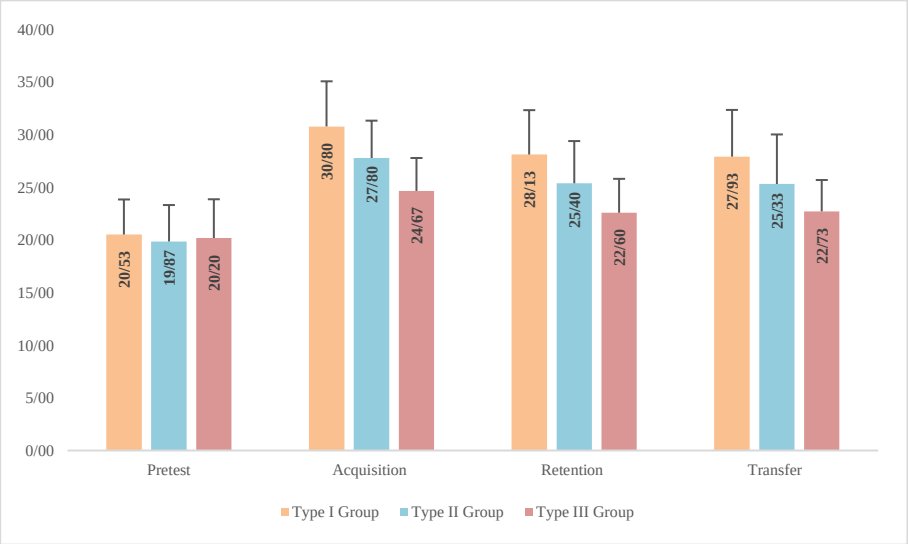
Figure 2

Mean Scores and Standard Deviations of the Groups in Four Stages



As indicated, the mean scores and standard deviations of the pretest scores obtained by Type I, Type II and Type III groups were found to be 20.53±3.33, 19.87±3.46 and 20.20±3.68, respectively. Similarly, those of the acquisition test were 30.80±4.29, 27.80±3.55 and 24.67±3.13, respectively. In the same way, those of the retention test were obtained to be 28.13±4.22, 25.40±4.01 and 22.60±3.22, respectively. Finally, those of the transfer test were found to be as follow: Type I group (M = 27.93, SD = 4.44), Type II group (M = 25.33, SD = 4.71) and Type III group (M = 22.73, SD = 2.98).

3.3. Inferential Statistics

To see to what extent the thinking styles affect volleyball serve learning skill, and whether there is a significant difference between thinking styles in this regard, a mixed ANOVA was conducted, the results of which are presented in Tables 3 and 4 and Figure 3.

Table 3

Tests of Within-Subjects Effects

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Time	Sphericity Assumed	1369.91	3	456.63	125.97	.00	.75
	Greenhouse-Geisser	1369.91	1.67	816.02	125.97	.00	.75
	Huynh-Feldt	1369.91	1.82	751.06	125.97	.00	.75
	Lower-bound	1369.91	1.00	1369.91	125.97	.00	.75
Time * Group	Sphericity Assumed	162.85	6	27.14	7.48	.00	.26
	Greenhouse-Geisser	162.85	3.35	48.50	7.48	.00	.26
	Huynh-Feldt	162.85	3.64	44.64	7.48	.00	.26
	Lower-bound	162.85	2.00	81.42	7.48	.002	.26
Error	Sphericity Assumed	456.73	126	3.62			
	Greenhouse-Geisser	456.73	70.50	6.47			
	Huynh-Feldt	456.73	76.60	5.96			
	Lower-bound	456.73	42.00	10.87			

As presented, as the assumption of sphericity is violated, the values in the row of Greenhouse-Geisser are taken into consideration. The results showed that the main effect of time (F = 125.97, p < .05, η^2 = .75) and the interaction effect of time and group (F = 7.48, p < .05, η^2 = .26) on volleyball serve learning are significant. The partial eta squared values indicate a large effect size for the main effect of time, and a moderate effect size for the interaction effect of time and

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group. Therefore, the scores of volleyball serve learning obtained the groups significantly changed from the pretest to the transfer test, and that the groups responded differently over time. It is concluded that the thinking style significantly affected volleyball serve learning, and the thinking styles differ significantly in volleyball serve learning. To perform a pairwise comparison, a Tukey post hoc analysis was run, the results of which are indicated in **Error! Reference source not found.** and Figure 3.

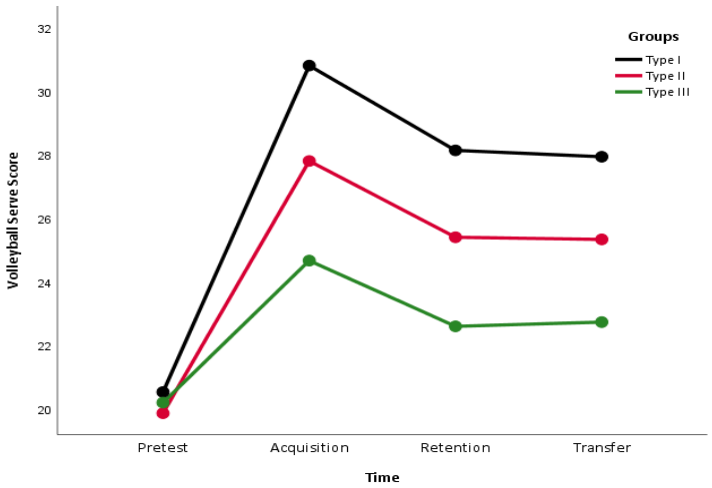
Table 4

Tukey Post Hoc Analysis

Groups	N	Subset 1	2
Type III	15	22.55	
Type II	15	24.60	24.60
Type I	15		26.85
Sig.		.24	.18

Figure 3

Volleyball Serve Scores of the Groups in the Four Stages



As presented, the results indicated (a) no significant difference between Type I and Type II groups, (b) no significant difference between Type II and Type III groups, and (c) a significant difference between Type I and Type III groups. In other word, the Type I group significantly outperformed the Type III group in terms of volleyball serve learning, and no substantial difference was seen between other groups.

4. Discussion and Conclusion

The findings showed that there is a significant difference between the Type I and Type III groups in volleyball serve learning, with the Type I outperforming Type III in all stages of acquisition, retention, and transfer. Although the Type II group indicated a greater increase in volleyball serve learning, compared to Type III group, this increase was not statistically significant in all stages of acquisition, retention, and transfer. These findings are consistent with those of Sternberg and Grigorenko (19), Sternberg and Grigorenko (20), Zhang and Sternberg (21), Albaili (22), Cano-García and Hughes (10), and Zhang (23); however, they are not in line with those of Bernardo et al. (9).

Although, in schools, the individual differences in thinking styles are often mistakenly attributed to abilities, students can be most effective when they rely on their

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thinking styles for achieving the best performance. Those students whose thinking styles are not in line with that of the teacher are often considered to be slow-witted in schools. Depending on to what extent their educational environment aligns or conflicts with their thinking styles, students might show better or worse academic achievement.

Saad and Aljuboury (24) found that the functional thinking style significantly contributes to learning the accuracy of block and smash serves in volleyball, and that teaching through the active thinking model needs to be encouraged in order to interact with the two skills to be learned in volleyball. They (24) found that acquisition of skills (e.g., planning, organizing, etc.) through the active thinking model leads to significantly better performance of volleyball skills. These findings are in line with those of the present study in which it was found that the creative thinking style (Type I), which is almost similar to the active thinking style, led to a better performance in volleyball serve learning.

The enrichment of educational process by finding effective tools that stimulate learners' minds helps facilitate the acquisition, storage, and retrieval of information (25). The researchers believe that such superiority seems to be due to the fact that the creative thinking model is designed to improve the players' thinking ability, as it depends on a set of cognitive tools that go beyond cognition (26). Also, using the creative thinking model encourages players to write and participate, decreasing their fear and shyness, increasing their self-confidence, and encouraging them to express their feelings and opinions away from direct criticism that might limit and hinder creativity (27).

Creative thinking plays an important role in physical education. Several studies emphasized the importance of developing creative thinking skills in this field (28). Creative thinking is not well studied in the related literature, and further research is needed in this regard. It is worth noting that children can develop their creative thinking skills in their own ways. Botagariyev et al. (29) indicated that students' creative thinking is improved through physical education programs. Fattah et al. (14) found that the female students with liberal thinking style enjoy mental fitness, mental motivation, and performing serve skills, but those with conservative thinking style were found to have weaker performance in this regard. This might be due to the fact that female students with liberal thinking style tend to avoid being ordinary, and they have a greater ability to think and use mental processes, while those with conservative thinking style tend to follow everything that seems familiar and is common (14).

This is in line with the findings of Ghazi and Abdul-Sameea (27) which indicated that the higher the mental motivation, the better the artistic gymnastics skills. The conservative thinking style adheres to rules and traditions, is characterized by adherence to the prevailing rules and conditions, and is not willing to make rapid changes, but rather believes that natural growth is just enough to make changes and that mental motivation helps learners to highlight their abilities (14). The mental readiness is more complex and requires a lot of effort and long-term investment and only appears in people who have strong motivation and reasons, making them strive to differentiate themselves from others and provide themselves with more opportunities.

A comparative study, focusing on the differences between liberal and conservative thinking styles, specifically in the context of fitness, mental motivation and volleyball skill performance, showed that different cognitive frameworks affect athletes' performance and motivation levels (30). A study, looking more deeply into the relationship between thinking styles, well-being and behaviors in athletes, highlighted the role of cognitive perspectives in sports (31). The findings of such studies suggest that athletes with a strong awareness of how thinking processes affect performance may benefit from appropriate mental strategies to enhance their competitive advantage. Furthermore, empirical data suggest that volleyball athletes, compared to non-athletes, demonstrate superior performance on executive functions and visuo-spatial attention processing tasks, emphasizing the potential cognitive benefits that specialized training in volleyball may confer (32). This reinforces the idea that developing specific thinking styles and cognitive skills can significantly develop athletic performance in volleyball and other sports.

The controversies surrounding the thinking styles often center on the debate over the best approach to coaching and developing athletes. Some argue that an overemphasis on task-based training (Type III) may limit creativity and flexibility, while others believe that fostering creativity

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(Type I) without a solid foundation in skill acquisition can lead to inconsistent performance (33). Ultimately, integrating task-based, norm-favoring, and creativity-generating thinking styles in sports enriches athletic training, and significantly contributes to development of cognitive skills. Those athletes who effectively use these three thinking styles are equipped better to manage complex challenges in sports and to apply innovative solutions in various aspects of their lives (34). It is suggested that future studies examine the interactions between thinking styles and teaching styles in different sports with a larger number of participants.

Considering the effect of thinking styles on learning sport skills, we can suggest to the main sports administrators to pay more attention to the issue of thinking styles to improve sport performance. The present study encourages other researchers to expand the different dimensions of thinking styles in various skills at different ages and in both genders. The effects of familiarity with various thinking styles include increasing self-sufficiency in tasks and self-confidence, increasing motivation and creating more enjoyment in continuing work, creating a more optimistic competitive environment, reducing inappropriate behaviors during training, cognitive and physiological changes, skillful progress in tasks, and application for all age groups, even the elderly.

Authors' Contributions

Authors equally contributed to this study.

Declaration

In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

Transparency Statement

Data are available for research purposes upon reasonable request to the corresponding author.

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Declaration of Interest

The authors report no conflict of interest.

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Ethics Considerations

The study adhered to the ethical guidelines for research with human subjects as outlined in the Declaration of Helsinki. After being informed of the study objectives, participants signed an informed consent form. Also, the proposal was approved by the Graduate Education Council in the presence of members of the Ethics Committee through letter 107/445042/1 on 2024-03-09 (1402-12-19).

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