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Information Article

The Effect of a Smartphone-Based Artificial Intelligence (ChatGPT) Brainstorming Strategy on Learning Forehand and Backhand Straight Drive Skills in Table Tennis for Students

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ABSTRACT

The present study aimed to investigate the effect of a smartphone-based artificial intelligence (ChatGPT) brainstorming strategy on the acquisition and learning of forehand and backhand straight drive skills in table tennis among undergraduate students. The research problem centered on establishing innovative pedagogical alternatives by synthesizing modern technological frameworks with contemporary instructional strategies to optimize motor skill learning.

Methods: A total of N = 20 second-year undergraduate male students aged 19–21 years from the Department of Physical Education, College of Education at the University of Garmian (academic year 2024–2025) were randomly sampled. Participants were randomly divided into two equal groups: an experimental group (n = 10) that acquired the target skills utilizing the smartphone-based AI (ChatGPT) brainstorming strategy, and a control group (n = 10) that followed the conventional, instructor-led pedagogical curriculum. Pre- and post-intervention technical performance tests were conducted for both forehand and backhand straight drive skills.

Conclusions: Integrating AI (ChatGPT)-driven brainstorming via mobile devices significantly enhances technical motor skill acquisition in table tennis.

Recommendations: The authors recommend systematically incorporating smartphone-based AI brainstorming strategies into the instructional curricula across various sports and athletic disciplines.

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1. Introduction

Contemporary educational trends emphasize the importance of modern learning approaches that shift the focus of the educational process from subject matter to the learner, enabling learners to acquire knowledge in accordance with their interests, aptitudes, and abilities, while the teacher assumes the role of a facilitator and guide. The educational process requires the effective utilization of students' talents, capabilities, and latent potential to support and enhance educational outcomes. Therefore, it is essential to adopt contemporary instructional strategies and technologies that foster creativity and idea generation when addressing complex problems, in conjunction with technological systems capable of assisting students in learning, thinking, and decision-making in ways that resemble human decision-making processes. Such integration can stimulate students' positive interaction and communication, increase their participation within the learning environment, and reduce reliance on traditional educational methods that primarily depend on the teacher's role in transmitting information to learners. Excessive reliance on such teacher-centered methods may suppress students' talents, promote complete dependence on the teacher, and diminish their creative potential. Accordingly, those responsible for the educational process should employ contemporary strategies that are appropriate to learners' abilities and capabilities and integrate them with modern technological systems and techniques to enable learners to attain a high level of competence and mastery, while developing cognitive flexibility and the ability to deal effectively with diverse situations.

The significance of the present study lies in the use of a contemporary instructional alternative represented by a brainstorming strategy integrated with ChatGPT-based artificial intelligence via smartphones, as opposed to the conventional instructional approach, for learning the forehand and backhand drive skills in table tennis. Brainstorming is considered an important and effective instructional strategy, as it closely reflects the associative processes through which conventional or familiar ideas emerge in the mind and subsequently develop into original ideas characterized by uniqueness in skill performance. One of the fundamental principles of brainstorming is that quantity is more important than quality; that is, the greater the number of ideas generated, the greater the likelihood of obtaining useful ideas (Khalid, 2011, p. 107).

The research problem stems from the researchers' specialization in teaching within the field of physical education. Based on their experience in this field, they observed that the educational process within the learning environment requires the introduction of alternative instructional approaches through the use of modern and advanced instructional strategies and technologies to achieve more effective outcomes in teaching and mastering motor skills. This requires the adoption of contemporary and advanced instructional alternatives to conventional teaching methods, in line with the ongoing scientific and technological advancements in educational tools, particularly the emergence of modern instructional strategies and technological systems characterized by advanced technologies that contribute to the provision of an integrated learning environment.

From this perspective, the researchers sought to address the research problem by employing a brainstorming strategy integrated with ChatGPT-based artificial intelligence via smartphones in learning the forehand and backhand drive skills in table tennis during physical education lessons.

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Artificial Intelligence (AI): Artificial intelligence is a branch of computer science concerned with the study and design of intelligent systems capable of simulating human behavior through perceiving their surrounding environment, analyzing information, and making appropriate decisions in ways that contribute to achieving predetermined objectives with the highest possible level of efficiency (Russell, 2021, p. 1).

ChatGPT: ChatGPT is a generative artificial intelligence system capable of providing information and textual analyses instantaneously. It is used as a supportive tool in the educational process within the field of physical education by providing students with theoretical concepts, explaining scientific terminology, supporting the preparation of reports and research papers, and enhancing the cognitive understanding of motor skills, rules, and sports regulations (Jamal Al-Din, 2024, p. 188).

Research Objectives

The study aims to:

1. Identify the effect of a brainstorming strategy integrated with ChatGPT-based artificial intelligence via smartphones on students' learning of the forehand and backhand drive skills in table tennis.
2. Identify which group demonstrates better performance in learning the forehand and backhand drive skills in table tennis.

Research Hypotheses

The study hypothesizes that:

1. There are statistically significant differences between the pre-test and post-test results of the two research groups (experimental and control) in students' learning of the forehand and backhand drive skills in table tennis.
2. There are statistically significant differences between the post-test results of the two research groups (experimental and control) in students' learning of the forehand and backhand drive skills in table tennis.

Research Scope

Participants: Second-year students in the Department of Physical Education, College of Basic Education, University of Garmian.

Time Frame: From October 20, 2024, to December 29, 2024.

Setting: The sports field of the Department of Physical Education, College of Basic Education, University of Garmian.

2. Research Methodology and Field Procedures

2.1 Research Method

The researchers employed the experimental method using an equivalent-groups design with pre- and post-tests, as this design was appropriate to the nature and objectives of the study.

2.2 Research Population and Sample

The research sample was purposively selected from second-year students in the Department of Physical Education, College of Basic Education, University of Garmian, during the 2024–2025 academic year. The research population consisted of 43 students. From this population, the researchers selected 20 students, who were divided into two groups. Ten students constituted the experimental group and completed the instructional units designed for learning the forehand and backhand drive skills in table tennis using a brainstorming strategy integrated with ChatGPT-based artificial intelligence via smartphones. The other 10 students constituted the control group and completed the

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instructional units for the same two skills using the conventional teaching method adopted by the course instructor.

In addition, six students were randomly selected to participate in the pilot experiment. Overall, the participants ranged in age from 19 to 21 years. They were of the same sex and academic level, and most belonged to the same age group. They were novice students with no previous practice experience in table tennis. The research sample was selected randomly using the lottery method.

A number of individuals were excluded from the sample, including female students, students who had repeated the academic year, students who practiced the sport in clubs, students whose studies had been deferred for more than one year, and students who had missed more than two instructional units or had not participated in one of the skill tests. These exclusions were made to ensure equivalence among participants and to minimize potential confounding variables during the implementation of the main experiment, particularly with respect to age and skill-test performance. Students who participated in the pilot experiment were also excluded from the main research sample.

The final research sample represented 46.5% of the total research population, which was considered an adequate representation of the study population, as shown below:

Table 1. Distribution of the Research Sample According to the Two Study Groups

Total	Sample Size		Excluded Participants		
	Experimental Group	Control Group	Female Students	Pilot Sample	Other Cases
43	10	10	5	6	12
			23		

2.3 Experimental Design

The researchers employed an experimental design known as the **randomized equivalent-groups pre-test–post-test design** (Abduljalil, 1981, p. 112), as illustrated in Figure 1.

No.	Group	Pre-test	Independent Variable	Post-test
1	Experimental Group	Technical Performance of the Forehand and Backhand Drive Skills in Table Tennis	Learning the Two Skills Using a Brainstorming Strategy Integrated with ChatGPT-Based Artificial Intelligence	Technical Performance of the Forehand and Backhand Drive Skills in Table Tennis
2	Control Group		Conventional Instructional Program	

Figure 1. Experimental Design of the Study

2.4 Data Collection Methods

2.4.1 Questionnaire

A questionnaire was used to determine the validity and suitability of the skill-performance evaluation form for assessing the forehand and backhand drive skills in table tennis. Since table tennis skills are among the basic three-phase motor skills comprising the preparatory, main, and final phases and are performed as a single movement sequence, the researchers relied on the observable structure of movement when evaluating the skill performance of the forehand and backhand drive.

Accordingly, the researchers prepared the questionnaire forms presented in Appendices (1A) and (1B) and submitted them to a group of specialists in motor learning, teaching methods, and table tennis (Appendix 2). The total score allocated to each of the forehand and backhand drive skills was set at 10 points, based on the percentage of

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agreement among the specialists regarding the relative importance of each observable phase of the skill.

Table 2 presents the percentage of agreement among the specialists concerning the score assigned to each phase of the forehand and backhand drive skills. Based on these results, the researchers prepared the skill-performance evaluation form for both the pre-test and post-test assessments, as shown in Appendix (1B).

Table 2. Percentage of Agreement Among Specialists on the Scores Assigned to Each Phase of the Forehand and Backhand Drive Skills in Table Tennis

No.	Skills	Movement Phases Score			Specialists		Agreement Percentage
		Preparatory	Main	Final	Total	Number in Agreement	
1	Forehand Drive	3	5	2	5	5	100%
2	Backhand Drive	3	5	2	5	4	80%

2.4.3 Skill Tests

First: Forehand Drive Skill Test (Reda Habib, 2005, p. 60)

Purpose of the Test:

To assess the learning of the forehand drive skill.

Equipment Used:

A table tennis table, a table tennis ball, and a table tennis racket.

Performance Procedure:

The participant stands in front of the table tennis table and performs the forehand drive repeatedly. Each participant is given three attempts.

Scoring:

The participant's performance across the three attempts is evaluated by a panel of experts. The final evaluation score is 10 points, distributed as follows:

1. Preparatory phase: 3 points.
2. Main phase: 5 points.
3. Final phase: 2 points.

Second: Backhand Drive Skill Test

Purpose of the Test:

To assess the learning of the backhand drive skill.

Equipment Used:

A table tennis table, a table tennis ball, and a table tennis racket.

Performance Procedure:

The participant stands in front of the table tennis table and performs the backhand drive repeatedly. Each participant is given three attempts.

Scoring:

The participant's performance across the three attempts is evaluated by a panel of experts. The final evaluation score is 10 points, distributed as follows:

1. Preparatory phase: 3 points.
2. Main phase: 5 points.
3. Final phase: 2 points.

Figure 2. The Three Basic Technical Skill Tests

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2.4.4 Scientific Technical Observation

Indirect scientific observation was conducted by three evaluators (Appendix 3) specializing in racket sports and table tennis. The observation was carried out during both the pre-test and post-test assessments of the research sample in the basic technical skills of table tennis, using the evaluation form prepared for this purpose.

2.5 Devices and Equipment Used

The following devices and equipment were used in the study:

1. One HP computer.
2. Four DONIC wooden table tennis tables.
3. Twenty-five LOKI table tennis rackets.
4. Forty LOKI table tennis balls.
5. Two HUAWEI video cameras.
6. A medical weighing scale for measuring body mass (kg).
7. A metal measuring tape for measuring height (cm).
8. Recording forms and pens.

2.6 Homogeneity and Equivalence of the Research Groups

2.6.1 Homogeneity in Age, Height, and Body Mass

Before implementing the instructional program, the researchers verified the homogeneity and equivalence of the two research groups in order to minimize the influence of extraneous factors that might affect the results of the experiment and to enable any observed differences to be attributed to the experimental factor. Accordingly, homogeneity between the participants in the experimental and control groups was examined with respect to age, height, and body mass. Table 3 presents the results of the homogeneity analysis.

Table 3. Homogeneity of the Experimental and Control Groups

No.	Variables	Unit.	Experimental Group		Control Group		*t*-value	Seg.
			M	*SD*	*M*	*SD*		
1	Age	Years	20.4	1.24	20.3	1.25	0.306	*NS*
2	Height	cm.	176.0	7.127	179.43	5.924	0.986	*NS*
3	Body Mass	Kg	71.24	11.44	71.90	6.61	1.528	*NS*

*** Significant at an error probability level of $p < 0.05$**

2.6.3 Skill Equivalence of the Two Research Groups

Skill equivalence between the two research groups was established for the forehand and backhand drive skills in table tennis. The researchers employed the three previously mentioned evaluators to assess the skill performance of the research sample using the evaluation form presented in Appendix (1), Form (B). The evaluators assigned scores after viewing CDs containing complete video recordings of the students' performances captured using a video camera. The mean of the three evaluators' scores was then calculated to obtain the final score for each skill for each student.

Each skill was evaluated according to its motor-performance phases specified in the evaluation form. To verify the objectivity of the assessment among the three evaluators, one of the skills was randomly selected, namely the forehand drive skill. The multiple correlation coefficient among the scores assigned by the three evaluators was calculated and yielded a value of 0.88, indicating a high degree of objectivity in the evaluation process. An objective test is one in which there is no discrepancy among the judgments of evaluators when the participant's performance is assessed by more than one evaluator (Mohammed & Hammoudi, 1987, p. 359).

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These results were subsequently adopted as the pre-test scores and were used for comparison with the post-test results, as presented in Table 4.

Table 4. Statistical Parameters of Equivalence Between the Experimental and Control Groups in the Forehand and Backhand Drive Skills in Table Tennis

No.	Variables	Unit.	Experimental Group		Control Group		*t*-value	Seg.
			M	*SD*	*M*	*SD*		
1	Forehand Drive	Degree	4.66	0.64	4.49	0.50	0.68	*NS*
2	Backhand Drive	Degree	4.63	0.55	4.77	0.36	0.65	*NS*

*** Significant at an error probability level of 0.05, with 28 degrees of freedom; the tabulated *t*-value = 1.734.**

2.7 Instructional Program

The instructional program consisted of 24 instructional units distributed between the two research groups, with 12 units allocated to each group, as follows (Appendix 3):
12 instructional units → using the brainstorming strategy integrated with ChatGPT-based artificial intelligence → Experimental group
12 instructional units → using the conventional instructional program → Control group
The actual experiment lasted for six weeks. During this period, each group completed two instructional units per week. The duration of each instructional unit was 90 minutes. The instructional units were similar in the preparatory and concluding sections, whereas the difference between the two groups was confined to the main section of the instructional unit.

2.8 Post-Tests

The post-tests for the forehand and backhand drive skills were conducted on Monday, December 9, 2024, using the same procedures employed in the pre-tests.

3. Presentation and Discussion of the Results

3.1 Presentation of the Comparative Results Between the Pre- and Post-Tests of the Two Research Groups (Experimental and Control) in the Performance Evaluation of the Forehand and Backhand Drive Skills in Table Tennis

3.1.1 Presentation of the Comparative Results Between the Pre- and Post-Tests of the Experimental Group in the Performance Evaluation of the Forehand and Backhand Drive Skills in Table Tennis

Table 5. Statistical Parameters of the Pre- and Post-Test Results of the Experimental Group in the Performance Evaluation of the Forehand and Backhand Drive Skills in Table Tennis

No.	Variables	Pre-test		Post-test		*t*-value	Seg.
		M	*SD*	*M*	*SD*		
1	Forehand Drive	4.66	0.65	7.20	0.58	10.33	*S*
2	Backhand Drive	4.62	0.55	7.23	0.37	11.40	*S*

*** Significant at an error probability level of 0.05, with 14 degrees of freedom; the tabulated *t*-value = 1.833.**

3.1.2 Presentation of the Comparative Results Between the Pre- and Post-Tests of the Control Group in the Performance Evaluation of the Forehand and Backhand Drive Skills in Table Tennis

Table 6. Statistical Parameters of the Pre- and Post-Test Results of the Control Group in the Performance Evaluation of the Forehand and Backhand Drive Skills in Table Tennis

No.	Variables	Pre-test		Post-test		*t*-value	Seg.
		M	*SD*	*M*	*SD*		
1	Forehand Drive	4.50	0.50	5.62	0.33	8.07	*S*
2	Backhand Drive	4.77	0.35	5.93	0.29	6.55	*S*

*** Significant at an error probability level of 0.05, with 14 degrees of freedom; the tabulated *t*-value = 1.833.**

With 14 degrees of freedom, the calculated *t*-value was greater than the tabulated *t*-value, indicating statistically significant differences between the pre-test and post-test results in favor of the post-test.

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3.1.3 Discussion of the Comparative Results Between the Pre- and Post-Tests of the Two Research Groups (Experimental and Control) in the Performance Evaluation of the Forehand and Backhand Drive Skills in Table Tennis

Tables 5 and 6 show statistically significant differences between the pre-test and post-test results of both research groups (experimental and control) in learning the forehand and backhand drive skills in table tennis, in favor of the post-test. The researchers attribute these differences to the effectiveness of both instructional programs in facilitating learning. Accordingly, the first research hypothesis was supported, as the students achieved better results in the post-test.

This improvement can be explained by the learning process, in which each of the two skills was explained by the instructor and demonstrated through a practical model, enabling the students to develop a clear mental representation of the skill by observing the demonstrated performance before attempting its execution. Abdul Ali Naseef stated that "the learner must have a clear idea of the skill to be learned, particularly the important points related to the movement sequence. The students then attempt to visualize the movement; thus, the three elements of demonstration, explanation, and visualization provide the learner with an accurate and coordinated perception of the movement" (Abdul Ali, 1987, p. 122).

Regarding the experimental group, the post-test results showed greater improvement than those of the control group, indicating that the instructional program based on the brainstorming strategy was more effective than the conventional instructional program in learning the forehand and backhand drive skills in table tennis. The instructional program incorporating the brainstorming strategy had a notable positive role in facilitating the learning of both skills, as "the brainstorming strategy enhances creativity and idea generation when solving complex problems, while also improving teamwork, increasing communication and active participation, and motivating students to develop their ideas" (Khalid, 2011, p. 154).

This effect was particularly evident when ChatGPT-based artificial intelligence was used during the students' performance of the exercises, as artificial intelligence can assist in data analysis, performance prediction, and injury prevention. It has been described as "a field concerned with developing technological systems capable of learning, thinking, and making decisions in ways similar to humans" (Zahraa, 2024, p. 2).

With regard to the control group, which was taught using the conventional instructional program adopted by the course instructor, the skill was explained and demonstrated by the instructor, followed by the students' direct practice of both skills. This approach had a positive effect on their performance and enhanced their ability to understand and comprehend the different phases of the motor skill and to perform them correctly. Jameel Mahmoud Hassan stated that "the learning of motor skills does not depend solely on the theoretical aspect (the instructional component); rather, the practical aspect (the application component) plays an important role in motor skill learning. Various and diverse exercises addressing all essential aspects of motor skill learning are provided during the instructional units, which is positively reflected in the level of performance" (Jameel, 2008, p. 40).

Meinel also indicated that "the stages of learning begin with understanding the task to be learned, which is achieved through the explanation and demonstration of

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movements. At this stage, the learner develops an initial conception of the movement pathway, which remains in its preliminary form" (Kurt, 1983, p. 152).

3.2 Presentation of the Comparative Post-Test Results Between the Two Research Groups in Learning the Performance of the Forehand and Backhand Drive Skills in Table Tennis

Table 7. Statistical Parameters of the Post-Test Results of the Experimental and Control Groups in the Performance Evaluation of the Forehand and Backhand Drive Skills in Table Tennis

No.	Variables	Experimental Group		Control Group		*t*-value	Seg.
		M	*SD*	*M*	*SD*		
1	Forehand Drive	7.20	0.58	5.62	0.33	7.17	*S*
2	Backhand Drive	7.23	0.37	5.93	0.29	8.33	*S*

*** Significant at an error probability level of 0.05, with 28 degrees of freedom; the tabulated *t*-value = 1.734.**

3.2.1 Discussion of the Comparative Post-Test Results Between the Experimental and Control Groups in Learning the Forehand and Backhand Drive Skills in Table Tennis

Table 7 shows statistically significant differences in the post-test results between the experimental and control groups in favor of the experimental group in learning the forehand and backhand drive skills in table tennis.

The researchers attribute the improvement observed in the students' performance of both skills, particularly within the experimental group, to the effectiveness of the instructional program based on the brainstorming strategy integrated with ChatGPT-based artificial intelligence. This instructional approach had a clear effect on students' acquisition of the two skills by encouraging communication and active participation during problem-solving activities. Brainstorming has been described as "a creative technique used to generate the largest possible number of ideas about a particular problem or topic through a free and collaborative discussion session, in which unconventional ideas and the development of others' ideas are encouraged" (Khalid, 2011, p. 130).

The students also benefited from the instructional activities, whether through explanation or the complete demonstration of both skills during the instructional units. These activities contributed to providing a clear and comprehensive understanding of the skills to be learned and helped the students better understand the nature, content, and components of each skill, particularly because the instructional program represented a new learning experience for them.

Mohammed Mahmoud Al-Hilah indicated that "instructional media facilitate communication and the transmission of educational objectives from the teacher to the learner. They enhance the effectiveness and quality of the learning process, motivate learners to participate more actively in instructional situations, increase their interest in continued learning, and facilitate retention through the retrieval of information" (Mohammed, 2001, p. 30).

As for the control group, the results also demonstrated an improvement in the level of skill performance in the forehand and backhand drive skills in table tennis. The researchers attribute this improvement to the students' continued participation in the learning process according to the conventional instructional program. However, this improvement was relatively lower than that observed in the experimental group. The researchers attribute this difference to the traditional teaching method adopted by the instructor, which placed greater emphasis on the practical aspect, while the cognitive

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aspect did not receive sufficient attention. In addition, limited use of modern and advanced instructional media reduced the availability of effective learning support for students, which in turn resulted in comparatively lower motivation toward learning.

Thus, it is evident that the instructional program based on the brainstorming strategy integrated with ChatGPT-based artificial intelligence and the conventional instructional program adopted by the instructor did not have equal effects. The program used with the experimental group was more effective than the conventional program used with the control group. Accordingly, the second research hypothesis was supported.

4. Conclusion

The findings of the study demonstrated the effectiveness of the instructional program based on the brainstorming strategy integrated with ChatGPT-based artificial intelligence via smartphones in learning the forehand and backhand drive skills in table tennis.

The conventional instructional program implemented by the course instructor was also effective in improving the learning of the forehand and backhand drive skills in table tennis. However, the experimental group, which followed the instructional program based on the brainstorming strategy integrated with ChatGPT-based artificial intelligence via smartphones, showed greater improvement than the control group, which followed the conventional instructional program.

Accordingly, the researchers recommend utilizing instructional programs that integrate brainstorming strategies with ChatGPT-based artificial intelligence via smartphones in the learning process. They also recommend conducting similar studies on other sports activities and events, across different age groups, and with participants of both sexes.

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Appendices – Appendix (1A)

No.	Evaluation Scores	1 2 3 4	1 2 3 4 5 6	1 2 3 4	10
	Observable Structure / Skills	Preparatory Phase	Main Phase	Final Phase	
1	Forehand Drive				
2	Backhand Drive				

*** The total score for the three phases of each skill must equal 10 points.**

Appendix (1B)

Evaluator's Name: _____ Academic Title: _____

No.	Evaluation Scores	Forehand Drive				Backhand Drive			
	Observable Structure / Skills	Prep.	Main	Final	Totel	Prep.	Main	Final	Totel
	Names	3	5	2	10	3	5	2	10
1									
2									

Appendix (2): Names of Experts and Specialists

No.	Name	Academic Title	Specialization	Affiliation
1	Raed Mahous Zghairahjeej	Prof. Dr.	Motor Learning / Racket Sports (Table Tennis)	University of Baghdad, College of Physical Education and Sports Sciences
2	Iman Najm Al-Din Abbas	Prof. Dr.	Physiology and Training / Racket Sports	College of Physical Education and Sports Sciences, University of Sulaymaniyah
3	Amer Mohammed Khalil	Prof. Dr.	Training / Racket Sports (Table Tennis)	University of Mosul, College of Physical Education and Sports Sciences

Appendix (3): Names of Evaluators

No.	Name	Academic Title	Specialization	Affiliation
1	Akram Abdul-Wahid Mohammed Amin	Prof. Dr.	Psychophysiology / Racket Sports (Table Tennis)	University of Salahaddin, College of Physical Education and Sports Sciences
2	Shilan Hussein Mohammed	Prof. Dr.	Motor Learning / Racket Sports	College of Physical Education and Sports Sciences, University of Sulaymaniyah
3	Ahmed Mohammed Ali Kamel	Prof. Dr.	Teaching Methods / Racket Sports	College of Physical Education and Sports Sciences, University of Salahaddin