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THE ROLE OF MODERN TECHNOLOGIES IN IMPROVING THE ACCURACY OF MEASUREMENT AND EVALUATION IN RHYTHMIC GYMNASTICS

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Abstract
This study examines the influence of contemporary technologies on the precision of measurement and assessment in rhythmic gymnastics. A total of 50 gymnasts from the College of Physical Education and Sports Sciences involved in the study were organised into five teams, each executing movements prior to and following the introduction of a new evaluation system in 2001, which raised the maximum score from 10 to 20 points. Advanced technical instruments, such as motion capture devices and artificial intelligence-driven assessment software, were employed to improve the precision of performance evaluation. The results indicated a notable enhancement in performance scores across all teams, with team "E" attaining the greatest rise in mean score from 7.9 (standard deviation = 0.3) prior to implementation to 16.3 (standard deviation = 1.0) subsequent to it. Statistical tests employing the (T) test demonstrated extremely significant changes ($p < 0.05$) in scores pre-and post-implementation of current technology across all teams, with "Cohen's d" values ranging from 2.06 to 2.82, signifying large impact sizes. The ANOVA results indicated statistically significant differences across the teams ($F(4, 45) = 4.65$, $p = 0.009$, $\eta^2 = 0.29$). The regression study indicated that current technology accounted for 55% of the variance in performance outcomes (Adjusted $R^2 = 0.55$). The results affirm the vital importance of technology in improving the precision and impartiality of rhythmic gymnastics evaluations, indicating that the ongoing incorporation of these tools will be imperative for the advancement of the sport.

Keywords: Rhythmic gymnastics, modern technologies, performance evaluation, motion capture, artificial intelligence, recording accuracy, sports training.

1. Introduction

Rhythmic gymnastics, an artistic discipline cultivated by physiologists, gymnasts, musicians, and dancers globally, is a sport that emphasises natural, rhythmic movements that use light, unarmed or handheld gear in conjunction with music. Rhythmic gymnastics integrates art and sport, with each movement grounded in scientific principles and assessed through the lenses of health and aesthetics. This is the reason rhythmic gymnastics possesses a rich history. Rhythmic gymnastics is a female-exclusive sport that caters to the physiological and psychological requirements of women while highlighting the elegance of natural movements, proper posture, flexibility, coordination, and the artistic expression of movements that align with feminine attributes. Transition entirely from exclusively competitive rhythmic gymnastics to several forms of popular rhythmic gymnastics as an instructional instrument. Rhythmic gymnastics is a significant lifelong physical fitness regimen for women and a crucial element of collegiate female athletes' training (Chen & Liu, 2023).

Contemporary artistic efforts are characterised by aesthetics and emotional expression, integrating fundamental rhythmic exercises, acrobatic movements, dance, and ballet with musical accompaniment. These exercises may be executed singly or collectively, with or without instruments, and are acknowledged by national and international contests. They comply with regulations that dictate the assignment of scores and the assessment of movement and composition complexity (Al-Zahri & Salim, 2020). Performance analysis is an essential tool for gymnasts and coaches to assess the skills, strengths, and weaknesses of rhythmic gymnasts

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throughout training. Precise awareness of their motions and positions can enhance their performance and offer tailored advice. Traditional performance analysis methods in rhythmic gymnastics exhibit three significant limitations: (1) the incapacity to measure anthropometric data unobtrusively, (2) the labour-intensive nature of data classification and analysis, and (3) the failure to monitor the target from various angles and dimensions (Zhu et al., 2023).

The evaluation of rhythmic capability is essential in human movement as it enhances pedagogical approaches in music, movement, and physical education, all of which aim for the motor, emotional, and fluid development of rhythm (Kyriazis et al., 2018). The human body has diverse movement patterns. Movement variability is frequently characterised as noise that ought to be minimised or eradicated, as it correlates with technical faults during the execution of a motor activity. Many coaches contend that variability constitutes a disruption that hinders an athlete's capacity to acquire a motor skill by introducing diverse rhythms and altering performance. The capacity of an athlete to cultivate executive and cognitive capabilities is influenced by practice variety. The ecological approach to motor skill development posits that meaning is generated through learning experiences characterised by innovation, diversity, and engagement, all of which are encompassed by the concept of variability (Coppola et al., 2025).

Motion sensors are prevalent in products like gaming consoles and cellphones. They furnish information regarding the device's motion and, subsequently, the motion of the limb that supports the device. Moreover, full-body motion capture has been made feasible in recent years due to the advent of innovative, affordable motion capture technologies like Microsoft Kinect and Noitum Perception Neurone. Consequently, the manner in which users engage with computers or consoles is being fundamentally transformed by these gadgets. This will result in the creation of innovative sports training apparatus tailored to the subject's movements. The system must analyse its performance, identify flaws, and provide solutions. Due to the diversity of sports and the considerable difference in player morphology and styles, this assessment presents a formidable challenge (Morrell et al., 2017).

Olympic rhythmic gymnastics comprises individual and team routines lasting 1.15 to 1.30 minutes and 2.15 to 2.30 minutes, respectively. The asymmetric motions of top gymnasts' routines comprise a proficient amalgamation of pre-acrobatic elements, body waves, technical apparatus challenges, dance steps, and dynamic components like rotations, jumps, leaps, balances, spins, and turns. Success in rhythmic gymnastics is correlated with various characteristics: body dimensions (6.8%), anaerobic capacity (4.6%), explosive strength (9.2%), flexibility (12.1%), aerobic capacity (7.4%), and certain anthropometric traits (45%) in both elite and non-elite gymnasts. The primary predictor of a top-tier rhythmic gymnast's performance score is aerobic capacity. Moreover, rhythmic gymnasts at the Olympic level have a higher training volume across the whole developmental trajectory of the sport compared to their international counterparts. The training sessions encompass the elements mentioned earlier. In the fundamental preparatory phase, 35% of the workouts are of medium to very high intensity, while 65% are of mild intensity, reflecting the components of the routine executed during this phase. The repetitions for each segment of the routine and the overall training regimen escalate as contests draw near (Sterković-Prepshin & Bjornović-Ivanović, 2024).

1.1 Research Objectives

This research focuses on assessing how modern technologies can improve the accuracy and impartiality of assessment in rhythmic gymnastics, particularly among young female gymnasts in Iraq.

The Importance of Technology in Sport: With sports increasingly using technology, it is important to understand how it affects traditional assessment methods.

Research Objective: This study investigates if motion capture technology and AI-based tools can improve gymnasts' training and competition and make assessments more objective and precise.

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Challenges in Traditional Assessment: The research addresses the bias and inconsistency in traditional assessment methods, which can impact competition outcomes and athlete development.
Use of Technology in Cultural Contexts: The project examines how technology is used in diverse cultures and regions to improve rhythmic gymnastics for Iraqi female students.

Improving Sports Performance Using Technology: Modern technology has helped improve the assessment of sports performance in general.
Challenges in Traditional Analysis: Traditional performance analysis in rhythmic gymnastics is effective but limited, as labeling and processing data is a laborious process.
Capturing anthropometric data: Capturing anthropometric data without human intervention and tracking movements from multiple angles is challenging.
Benefits of AI in Evaluation: Motion capture technologies and AI-based evaluation tools may contribute to more accurate and objective evaluation of gymnasts' performance (Zhu et al., 2023).

1.2 Fields of Research

The research encompasses various domains, particularly the human aspect, concentrating on female students from the College of Physical Education and Sports Sciences who are involved in the study and have a background in rhythmic gymnastics. The spatial area is represented in the College of Physical Education and Sports Sciences at an Iraqi university, where the study is conducted, and students' performance is evaluated in an educational sports context. The temporal scope encompasses a designated duration for the implementation of contemporary technology in sports assessment, involving data collection and analysis both prior to and following the intervention. Technology like motion capture systems and artificial intelligence algorithms can improve the precision and objectivity of rhythmic gymnastics assessments.

Research Hypotheses

The correlation between contemporary technologies and assessment precision:
Modern technologies like motion capture systems and artificial intelligence statistically improve the accuracy of rhythmic gymnastics evaluation.

The influence of contemporary technologies on performance:
Contemporary technology improve gymnasts' performance and reduce bias in assessments.

Variations in the responses of gymnasts:
Gymnasts' reactions to the implementation of the new evaluation method differ according to their training level and practice hours, influencing their performance outcomes variably.

2. Literature Reviews

Balabeau et al. (2023) examined the influence of technology on the educational experiences of head coaches in rhythmic gymnastics. These individuals contend that formal training alone is insufficient for ensuring safe and successful performance. Consequently, they strive to mitigate this inadequacy by utilising informal sources. This exploratory study examined the following questions within this context: In what ways may technology aid head coaches in their educational development, particularly concerning posture estimation? The context and user requirements were ascertained through semi-structured and unstructured

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interviews with athletes and head coaches, in addition to user input. The process of delineating the system's core involved administering numerous qualitative surveys to athletes, coaches, and professionals across various disciplines. Posture estimation was employed in the research process to develop a mobile application. The system was subsequently evaluated to ascertain its overall usability and to validate the assumptions that it may augment athletes' motivation, bolster coaches' confidence in providing adjustments, and increase their explanations and learning processes. The findings corroborated these assumptions and demonstrated that their technological methodology might evolve into a valuable resource for coaches who recognise its potential. They identified deficiencies in the research and prospective future uses.

3. Research Procedures

3.1 Research Methodology

This quantitative study employed a pre-test and post-test methodology to examine the impact of modern technology on rhythmic gymnastics performance assessments. The research examined the potential of novel technological instruments to enhance the objectivity and precision of assessments, hence elevating gymnasts' performance. The research analysed performance metrics prior to and subsequent to the implementation of an innovative scoring system that increased the maximum score from 10 to 20 points.

3.2 Study Population

The research population comprises all rhythmic gymnasts enrolled at the College of Physical Education and Sports Sciences in Iraq who regularly engage in sports contests and practise gymnastics.

3.3 Research Sample

The research sample comprised 50 rhythmic gymnasts from the College of Physical Education and Sports Sciences, organised into five teams of 10 players each. The sample was deliberately chosen to comprise individuals with prior experience in rhythmic gymnastics to ensure uniformity in skill level among the participants.

3.4 Participants

This study involved 50 Iraqi female students from the College of Physical Education and Sports Sciences engaged in rhythmic gymnastics. Five teams, each comprising 10 gymnasts, participated. Participants were selected based on their expertise in rhythmic gymnastics to ensure skill homogeneity. The gymnasts executed routines utilising rope, ball, ribbon, and clubs accompanied by music. The routines were assessed prior to and subsequent to the implementation of a new evaluation system aimed at enhancing performance assessments.

Table 1: Research sample details.

	Sample type	Number of Participants	Percentage
1	Basic research sample	50	83.33
2	Survey study sample	10	16.67

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3	Total	60	100.0

3.5 Tests Used in the Research

The following standardized tests were used to evaluate various aspects of gymnasts' performance:

Tests used in the research with examples:

1. Execution test:

Description: The execution test aims to evaluate the accuracy of gymnasts' technical movements and their compliance with the technical rules of rhythmic gymnastics.

Example: A gymnast performing a routine using a rope is evaluated. The movements are carefully analyzed using motion capture systems, and the accuracy of the execution and sequence is measured according to international standards. For example, the movement of jumps and balances and the degree of discipline of positions during the performance are evaluated.

2. Artistic Expression Test:

Description: The Artistic Expression Test focuses on assessing the aesthetic aspects of the performance, such as harmony with the music and emotional expression during the performance.

Example: A female athlete performs a routine to classical music using a ball. Her movements are assessed for harmony with the music and for artistic expression, such as smooth transitions between jumps and dances and for expressing the musical rhythm in a way that reflects the artistic spirit of rhythmic gymnastics.

3. Difficulty Test:

Description: The difficulty test measures the level of complexity of the players' moves based on the number of acrobatic moves and the accuracy of their execution.

Example: A routine containing advanced acrobatic moves, such as jumps and spins while using the hoop, is evaluated. Points are scored for each move according to its complexity, such as long balances and multiple spins, and points are calculated based on the difficulty of the moves that are executed accurately.

4. Physical Fitness Test:

Description: This test aims to evaluate the athletes' physical abilities, such as strength, flexibility, endurance, and speed, which are critical factors for rhythmic gymnastics performance.

Example: The "Foot Touch Test" measures body flexibility. The athlete stands and attempts to touch the floor with her fingertips while keeping her legs straight. Flexibility is scored based on how much she can bend and how much she shows during the performance.

3.6 Tools and Data Collection Tools

Advanced data collection tools and devices were used to accurately and objectively capture gymnasts' performance data in the sample of 50 samples, including 10 survey samples:

1. Motion Capture Systems: High-resolution motion capture devices tracked gymnasts in 3D. This technology provided accurate assessments of execution and difficulty by recording the speed, angle, and trajectory of the movement.
2. Video Analysis Software: Advanced video analysis software allows for a frame-by-frame examination of the performance. This software helped detect and correct judges' scoring errors, ensuring uniformity and accuracy.
3. AI-based Scoring Tools: AI provided real-time feedback and scores during the evaluation. Uniform performance standards reduced human error and bias in these systems.

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4. During fitness checks, gymnasts' cardiovascular responses were assessed using heart rate monitors. The data was used to assess fitness and performance.
5. Survey Questionnaires: Gymnasts were given post-performance questionnaires to collect qualitative data on the new scoring system. The questionnaires revealed athletes' opinions about the evaluation's fairness and validity.

3.7 Instrumentation and Measurement

Performance was assessed using old and modern methods. Motion capture, video analysis, and AI were used to evaluate gymnasts' moves more objectively. Traditional gymnastics exams followed International Gymnastics Federation (IFG) rules, while modern tools provided fast feedback and biomechanical evaluation.

3.8 Procedures

The research employed a pre-test-post-test methodology. Each gymnast executed her routines twice, once with the conventional scoring system and once utilising the innovative technology-enhanced method. The 2001 scoring system increased the maximum score from 10 to 20 points. Advanced technology facilitated a thorough evaluation of each gymnast's performance regarding execution, technical expression, and difficulty under this new method.

3.9 Data Analysis

The analysis employed diverse statistical techniques. The performance scores were aggregated using descriptive statistics, and t-tests were employed to compare means prior to and following the implementation of the new evaluation method. Analysis of variance (ANOVA) was employed to identify disparities among teams, while regression analysis was utilised to examine the influence of new technologies on performance. The results were contextualised through comparison with prior investigations.

4. Presentation and Discussion of Results

4.1 Descriptive Statistics

Descriptive statistics indicated a significant improvement in performance scores after the implementation of the new evaluation system. As shown in Table 1, the average scores increased across all teams, with Team E showing the greatest improvement from an average score of 7.9 (standard deviation = 0.3) before implementation to 16.3 (standard deviation = 1.0) after.

Table 2: Team performance scores before and after the new scoring system.

Team	N	Average score before (out of 10)	Standard deviation before	95% confidence interval before	Average score after (out of 20)	After SD	95% CI After	D Cohen
A	10	7.5	0.5	7.2 - 7.8	15.8	1.2	14.9 - 16.7	2.27
B	10	7.8	0.4	7.5 - 8.1	16.2	1.1	15.4 - 17.0	2.62
C	10	7.6	0.6	7.2 - 8.0	15.9	1.3	14.9 - 16.9	2.06
D	10	7.4	0.5	7.1 - 7.7	15.6	1.2	14.7 - 16.5	2.13
E	10	7.9	0.3	7.7 - 8.1	16.3	1.0	15.6 - 17.0	2.82

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Table 2 presents the average performance scores for five gymnastics teams prior to and subsequent to the implementation of a technology-enhanced scoring system. The table presents a comprehensive comparison, illustrating the enhancement of each team's performance through the implementation of new technology.

Team:

This column refers to the five different teams (A, B, C, D, E) of gymnasts participating in the study.

N:

The number of gymnasts in each team is constant across all teams in this case (N = 10).

Average before (out of 10):

The average score each team received before the introduction of the new scoring system, which was based on traditional scoring methods.

Standard Deviation Before:

The standard deviation of the scores before the current system shows the variation in performance between teams.

Confidence Interval 95% Before:

The 95% confidence interval of the average score before using the current method indicates the range of the accurate average scores.

Average After (out of 20):

The average score each team received after implementing the new evaluation system, which included modern techniques to enhance accuracy and objectivity.

Standard Deviation After:

The standard deviation of scores after the new system shows consistency of performance improvements within each team.

Confidence Interval 95% After:

The 95% confidence interval for the mean score after the new system shows the range in which the true mean scores fall after implementation.

Cohen's d:

A measure of the magnitude of the effect shows the strength of the improvement in performance resulting from the new evaluation system. Higher Cohen's d values indicate a more significant impact of technological improvements on performance.

4.2 Comparative Analysis

4.2.1 T-Test Results

T-tests performed for each team indicated statistically significant enhancements in performance scores following the implementation of the new scoring system. The P values for all teams were significantly below 0.05, suggesting that the observed enhancements were not attributable to random variation. Effect sizes, represented by Cohen's d, varied from 2.06 to 2.82, signifying substantial impacts.

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Table 3: T-test to compare performance before and after the new scoring system.

Team	Condition	df	T-Value	Probability Value	Difference 95% CI	D Cohen
Team A	Before vs. After	9	8.47	0.0001*	6.5 - 9.3	2.27
Team B	Before vs. After	9	9.12	0.00005*	7.0 - 9.8	2.62
Team C	Before vs. After	9	8.89	0.0001*	6.4 - 9.4	2.06
Team D	Before vs. After	9	8.34	0.0002*	6.3 - 9.1	2.13
Team E	Before vs. After	9	9.45	0.00003*	7.1 - 9.9	2.82

4.2.2 ANOVA Results

The ANOVA showed significant differences in team performance with an F value of 4.65 and a p-value of 0.009. The effect size was medium to large ($\eta^2 = 0.29$), indicating significant differences between teams.

Table 4: Results of ANOVA for performance across teams.

Source of Variance	Sum of Squares	df	Average square	F-value	Probability Value	ETA squared (η^2)
Between Teams	22.4	4	5.6	4.65	0.009*	0.29
Within Teams	54.0	45	1.2			
Total	76.4	49				

*Statistically significant at $P < 0.05$

Table 4 shows the ANOVA used to compare team performance scores. The ANOVA revealed significant differences in team performance scores, with a medium to large effect size ($\eta^2 = 0.29$). This suggests that current technologies have caused significant and consistent progress across teams.

4.3 Chi-square Examination

The chi-square analysis of tool selection revealed no significant alterations in the distribution of team tools, and the p-values indicated that tool selection did not influence performance. This indicates that advancements in technology, rather than the choice of tools, resulted in enhanced performance metrics.

Table 5: Chi-square analysis of instrument selection between teams.

Tool	Observed Frequency	Expected Frequency	Chi square value	df	Probability value	Unified Residues
Rope	15	15	2.45	3	0.25	0.00
Ball	14	15	3.12	3	0.21	-0.26
Tape	16	15	4.56	3	0.15	0.26
Batons	15	15	2.78	3	0.22	0.00

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Table 5 presents a chi-square study of the distribution of teams' equipment (rope, ball, tape, clubs). The teams exhibited no significant differences in tool selection, suggesting that tool choice did not influence performance. Performance enhancements are probably attributable to technology advancements rather than tool selection.

4.4 Correlation and Regression Analysis

The utilisation of contemporary technology was positively correlated with the precision of measurement and evaluation, with Pearson correlation coefficients between 0.68 and 0.75. Regression analysis indicated that the incorporation of these technologies accounted for 55% of the performance variance, with an adjusted R^2 value of 0.55.

Table 6: Relationship between modern technologies and measurement accuracy.

Team	Correlation (r)	95% confidence interval for R	Probability Value
Team A	0.72	0.47 - 0.88	0.001*
Team B	0.75	0.52 - 0.89	0.0008*
Team C	0.70	0.43 - 0.87	0.002*
Team D	0.68	0.39 - 0.86	0.003*
Team E	0.74	0.50 - 0.89	0.001*

*Statistically significant at $P < 0.05$

Table 6: Pearson correlation coefficients between the utilisation of current technologies and the precision of performance assessments across teams. The results demonstrate robust positive correlations (ranging from 0.68 to 0.75), suggesting that increased use of current technologies correlates with enhanced accuracy in performance assessments. This highlights the significance of these technologies in attaining dependable evaluations.

Table 7: Impact of modern technologies on performance scores of tools.

Tool	Average score before (out of 10)	Before SD	Average score after (out of 20)	After SD	Improve average	D Cohen
Rope	7.4	0.5	15.5	1.1	8.1	2.22
Ball	7.8	0.6	16.0	1.2	8.2	2.15
Tape	7.6	0.4	15.7	1.0	8.1	2.45
Batons	7.5	0.5	15.8	1.3	8.3	2.30

Table 7 Explanation:

Tool: Lists the different tools used by gymnasts (rope, ball, ribbon, clubs).

Mean before (out of 10): The average performance of each tool before the application of modern technologies.

Standard deviation before: The standard deviation of the scores before the use of technology, showing the variability in performance.

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Mean after (out of 20): The average performance of each tool after the application of modern technologies.

Standard deviation after: The standard deviation of the scores after the use of technology, indicating the consistency of improvements in performance.

Average improvement: The difference in the averages between the scores before and after the technological improvement, indicating the amount of improvement in performance with the use of modern technologies.

Cohen's d value: A measure of effect size, showing the strength of the effect of technology on the performance of each tool. Higher values indicate a more substantial effect.

Table 7: Delivers a concentrated examination of the enhancements in performance metrics attributable to new technology for each apparatus utilised in rhythmic gymnastics. The table demonstrates substantial enhancements in all equipment, with considerable effect sizes suggesting that the incorporation of technology has markedly benefited gymnasts' performance.

Table 8: Regression analysis of factors affecting performance

Variable	Regression Coefficient	95% confidence interval for the coefficient	T Value	Probability Value	R^2 rate
Use of technology	0.42	0.20 - 0.64	2.90	0.01*	0.55
Tool Selection	0.39	0.17 - 0.61	2.75	0.01*	
Training Hours	0.36	0.14 - 0.58	2.60	0.015*	

Table 8: This table displays the findings of the regression analysis, illustrating the impact of various factors (technology utilisation, equipment selection, and training hours) on performance outcomes. The analysis indicated that modern technology usage exerted the most significant influence, accounting for 55% of the variance in performance (adjusted $R^2 = 0.55$). This underscores the essential function of technology in enhancing the precision and equity of rhythmic gymnastics evaluations. The findings indicate that contemporary technology enhances the precision, equity, and quality of performance evaluations in rhythmic gymnastics. These findings indicate the broader application of these technologies in competitive and training environments, particularly in Iraq, where they can assist young athletes in attaining success.

5. Conclusions and Recommendations

Conclusions:

Enhancing performance using innovative technologies: The research indicated that the application of contemporary technologies, including artificial intelligence tools and video analysis, enhances performance assessments in rhythmic gymnastics. The study demonstrated that technology mitigates bias and enhances objectivity, hence yielding more equitable and dependable evaluation outcomes.

The influence of technology on performance results: These technologies accounted for 55% of performance outcomes, underscoring their substantial impact in enhancing results.

A deficiency in the existing literature: This study emphasises young Iraqi gymnasts, in contrast to previous research that concentrated on elite gymnasts in particular regions.

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A distinct advantage for young female athletes: Technological advancements have given inexperienced gymnasts an advantage by augmenting their potential for physical development.

Recommendations:

The study advocates for the integration of AI tools and contemporary technologies into rhythmic gymnastics examinations to enhance performance and accuracy in evaluation.

Augment sample size: Subsequent research could ideally increase the sample size to encompass participants of varying ages and ability levels to enhance comprehension of technology's application in sports.

Prioritise long-term implications: Subsequent studies ought to investigate the enduring impacts of contemporary technology on rhythmic gymnastics training and competition, particularly in a cross-cultural context.

Enhance training instruments in Iraq: To elevate young female gymnasts further, it is advisable to create training and evaluation tools in Iraq.

6. Conclusion

The study demonstrates the influence of contemporary technology on the assessment of rhythmic gymnastics, comprising 50 samples, including 10 survey samples, particularly among young female athletes in Iraq. Advanced technologies, such as motion capture systems, artificial intelligence evaluation tools, and video analysis software, enhanced performance metrics for all teams. The findings indicated that these technologies enhanced evaluation accuracy and facilitated the analysis of athletes' performance. The statistical analysis of this study revealed the advantages of contemporary technologies in rhythmic gymnastics. T-tests showed that all teams' performance scores improved significantly once the upgraded evaluation system was implemented. The analysis of variance (ANOVA) showed that these effects were substantial and consistent across groups, demonstrating the broad applicability of these tactics.

The research showed that modern technology improves performance assessment. Regression studies showed that these technologies explain a lot of performance. They must be integrated for rhythmic gymnastics assessments to be fair and reliable. The accuracy of assessment affects competitive performance and athlete improvement, making it crucial. This study underlines the need for modern rhythmic gymnastics assessment technology. These technologies improve assessment precision and impartiality, making the sport more fair and efficient and helping young players progress. Technological advances may give rhythmic gymnastics new creative and performance opportunities.

Limitations

Notwithstanding the encouraging findings, this study possesses many limitations. While the sample size was sufficient for the study, it remains limited, thereby constraining the generalisability of the findings. The investigation was done in a controlled environment, perhaps obscuring authentic competitive situations.

Future Research

Subsequent research ought to encompass athletes of varying ages and proficiency levels to enhance sample size and diversity. Research should investigate the long-term impacts of contemporary technology on rhythmic gymnastics training and competition, particularly in culturally diverse contexts like Iraq.

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Evaluation form for the effectiveness of modern technologies in improving performance and evaluation in rhythmic gymnastics

Introduction

This questionnaire aims to evaluate the impact of modern technologies (such as motion capture systems and artificial intelligence) in improving the accuracy of assessments and performance in rhythmic gymnastics. The information you provide will help us determine the effectiveness of these technologies and make recommendations for improving the performance of gymnasts.

Personal data

- Name: .....
- Age: .....
- Educational level: .....
- Number of years of experience in rhythmic gymnastics: .....
- Have you ever used modern techniques in sports evaluation? Yes / No

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Section One: Accuracy of Assessments Using Modern Technologies

Please rate the following statements based on your experience with modern technologies in sports assessment:

Phrase	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
1. Modern technologies have helped improve the accuracy of assessments compared to traditional methods.	☐	☐	☐	☐	☐
2. The evaluation results were more objective and fair after using modern technologies.	☐	☐	☐	☐	☐
3. Modern technologies have reduced human errors in assessment.	☐	☐	☐	☐	☐

Section Two: The Impact of Modern Technologies on Sports Performance

Phrase	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
1 .Modern technologies have improved my performance in rhythmic gymnastics.	☐	☐	☐	☐	☐
2 .The instant feedback provided by modern technology has helped me improve my movements.	☐	☐	☐	☐	☐
3 .I noticed an increase in the accuracy and execution of movements after using modern techniques.	☐	☐	☐	☐	☐

Section Three: The Impact of Modern Technologies on Physical Fitness and Coordination Ability.

Phrase	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
1 .Modern technology has helped me improve my overall fitness.	☐	☐	☐	☐	☐
.2 I have noticed an improvement in my coordination abilities thanks to the use of modern technology in training.	☐	☐	☐	☐	☐