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The effect of using a QR code-enhanced brochure on students' knowledge and skill learning outcomes

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Abstract: The objective of this study was to design a booklet supported by QR codes and assess its impact on cognitive achievement and the acquisition of gymnastics skills (front ball roll, ball back roll, and handstand). Technological applications play a crucial role in enhancing the teaching and learning experience. The study was conducted on 30 students from the College of Physical and Sports Sciences at the Hashemite University in Jordan. The participants were randomly divided into an experimental group and a control group, with 15 students in each group. The results of the study revealed that the experimental group, which utilized the QR Code-supported booklet, exhibited significantly higher scores and greater improvements compared to the control group. The experimental group demonstrated higher average scores in cognitive achievement and specific gymnastics skills, including forward roll, back roll, and handstand. The differences in improvement rates between the experimental and control groups were also notable. In this study, the intervention of the booklet with QR codes clearly improved the learning outcomes for the experimental group in terms of cognitive achievement and the learning of gymnastics skills ($P < 0.05$). Overall, this study highlights the positive impact of integrating QR codes into educational materials and processes. It suggests that the use of QR codes can be a valuable technological tool for improving learning outcomes and fostering student engagement. Furthermore, the study provides insights into future trends and possibilities for utilizing QR codes in educational settings.

Keywords: *Ball back roll, Front ball roll, Gymnastics, Handstand, Intelligence quotient, Knowledge, Quick response code, Skill learning.*

1. Introduction

The advent of mobile technologies has brought about significant transformations in our societies. It has revolutionized interpersonal interactions, communication methods, work practices, and leisure activities. Mobile devices, systems, and technologies have gained widespread acceptance and usage on a global scale. Consequently, the concept and significance of learning have also undergone a profound shift [1]. Mobile applications, including QR codes, offer various opportunities to enhance student achievement. Firstly, they enable easy access to educational content and resources, empowering students to retrieve information and study materials conveniently on their mobile devices [2]. This accessibility enhances the learning experience and provides additional support beyond the classroom [3]. Secondly, mobile apps can deliver interactive and engaging learning activities, making the learning process more enjoyable and effective [4]. Incorporating elements of ramification or interactive quizzes within these apps promotes active learning and improves knowledge retention. Moreover, mobile applications facilitate real-time communication and collaboration between students and teachers, fostering idea-sharing, question-asking, and feedback provision [5].

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Utilizing QR codes for teaching gymnastics skills can offer numerous advantages. Firstly, QR codes can be employed to track attendance and gather prompt learner evaluations of virtual teaching sessions, simplifying the process of monitoring engagement and obtaining feedback [6]. Also, QR codes can be used in evaluation systems that don't need any devices to accurately rate and analyse each gymnastics move, taking into account things like consistency, length, and regularity, giving full report on its quality [7]. The utilization of QR codes in a booklet can facilitate the acquisition of knowledge, information, and skills in various ways. A study conducted on the development of QR code-assisted pop-up book media for second-grade elementary school students received favorable feedback from subject matter experts, educational media experts, teachers, and students [8]. Furthermore, the implementation of an electronic competency verification process utilizing QR codes in the field of nursing has demonstrated significant benefits, including cost savings, enhanced application time, and overall satisfaction [9]. A study has investigated the effectiveness of QR code-oriented pocketbooks in fostering collaborative learning, creativity, and critical thinking among students. The study received positive feedback regarding the appearance, content, substance, practicality, and efficiency of these pocketbooks [10].

Due to the advancements in technology and the resulting changes in various fields, it has become necessary to utilize technology to effectively organize and facilitate various aspects of business. Gymnastics, being a sport that requires mastery of numerous motor skills and technical aspects, necessitates the adoption of modern methods and techniques to enhance the learning and mastery of these skills. This includes self-learning approaches to reduce training time and leverage the transfer of learning between similar skills, enabling the acquisition of multiple skills simultaneously and expediting the learning process. QR Code technology is one of the prominent modern technologies that can be utilized in this context. Therefore, it is crucial to research and design a proposed booklet supported by QR codes, which would enable learners to engage in practical, audio-visual experiences, acquire information, and actively interact with the materials to achieve the desired goals.

1.1. The Significance of the Research

The research holds significant importance due to its utilization of QR Code technology, which is a cutting-edge digital application in the field of education. QR codes enable the integration of virtual and physical reality through the use of smartphones, which have become a primary tool for accessing and storing information. By incorporating QR codes, the study aims to enhance the content of textbooks, provide additional support materials, facilitate understanding of terminology, and ultimately increase student engagement and interest in learning. Furthermore, the use of QR codes in education has the potential to improve learning outcomes, foster teamwork skills, and broaden students' cultural horizons. In the context of sports and physical education, particularly gymnastics, which holds significant interest among learners, the application of QR code technology can offer valuable opportunities for enhancing skill acquisition and overall learning experiences.

1.2. Objectives

The purpose of this study is to create a booklet that utilizes QR Code technology and investigate its effects on cognitive achievement and the acquisition of gymnastics skills, specifically rolling the ball forward, rolling the ball backward, and performing a handstand.

1.3. Study Hypotheses

The research objective led to the formulation of the following hypotheses:

a) There will be statistically significant differences between the average scores of the pre- and post-measurements of the experimental group in terms of cognitive achievement and the acquisition of gymnastics skills, with higher scores observed in the post-measurement.

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b) There will be statistically significant differences between the average scores of the pre- and post-measurements of the control group in terms of cognitive achievement and the acquisition of gymnastics skills, with higher scores observed in the post-measurement.
c) There will be statistically significant differences between the average scores of the post-measurements of the experimental and control groups in terms of cognitive achievement and the acquisition of gymnastics skills, with higher scores observed in the experimental group.

2. Materials and Methods

2.1. Research Sample

The research population was comprised of 50 students from the Faculty of Physical and Sports Sciences at The Hashemite University in Jordan during the academic year 2022-2023, second semester. A purposive sample of 30 students was selected from this population and divided equally into two groups, with each group consisting of 15 students. The experimental group utilized an educational program that incorporated a booklet supported by QR code technology (see Appendix A), while the control group followed a traditional educational program involving explanation and model performance without the use of QR code (see Appendix A). Informed consent forms were provided to all participants.

It is clear from Table 1. These statistics provide an overview of the demographic characteristics and IQ scores of the participants in both groups. It is important to note that the differences in means and standard deviations between the experimental and control groups are minimal, suggesting that the groups are relatively similar in terms of age, height, weight, and IQ.

Table 1.
Mean, deviation, for age, height, weight, and IQ.

Variables	Experimental N=15		Control N=15	
	Mean	SD	Mean	SD
Age (Year)	20.44	0.50	20.53	0.52
Height (cm)	175.11	0.76	175.40	0.63
Wight (kg)	66.07	0.80	66.20	0.56
IQ (Score)	52.88	0.73	52.80	0.68

2.2. Research Instruments

2.2.1. Performance Evaluation Form for the Gymnastics Skills Under Study

The researcher developed a performance evaluation form to assess the student's proficiency in the gymnastics skills being studied. The purpose of the form was to evaluate the student's performance based on the research objectives. The form included the identification of the technical stages involved in each skill and the specific components that needed to be observed during performance. To determine the scoring system for each skill, the researcher initially presented the form to experts in the field of gymnastics and teaching methods. After gathering their opinions, the final form was established, with each skill being assigned a maximum of 10 scores. The evaluation process involved a committee of three arbitrators who were experts in gymnastics and had a minimum of 10 years of experience. These arbitrators were members of the teaching staff in physical education colleges. Averaging the combined scores provided by the three arbitrators yielded the score for each skill. The arbitrators used a prepared form for the evaluation process (see Appendix B).

2.2.2. Cognitive Achievement Test: (see Appendix C)

The objective of the test was to assess the cognitive achievement level of students in the College of Physical Education and Sports Sciences at Hashemite University. To determine the test dimensions and their respective significance, the researcher referred to the description of the gymnastics course. The test comprised three main dimensions: historical development, regulations, and skill aspects. To gather expert opinions on the test dimensions and their relative importance, the researcher developed a survey

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form. The experts were asked to indicate their level of agreement on the relative importance of each main dimension. The percentage of agreement among the experts regarding the determination of the relative importance of each main dimension is presented. The historical development dimension was determined to have a relative importance of 10%; the game law was also determined to have a relative importance of 10%; and the skill aspect dimension was determined to have a relative importance of 80%.

The researcher initially created the test vocabulary, which consisted of 40 items split among the three test dimensions. Care was taken to ensure that each vocabulary item had a specific meaning, used the correct language, and avoided ambiguity or multiple interpretations. Test instructions were developed, instructing students to carefully read each question and answer, not to leave any question unanswered, and to allocate one mark for each question. An example answer was provided for reference. The initial test draft was presented to a group of experts to assess its validity. The experts showed an agreement of 80% regarding the suitability of the test questions to the sample members' level. Necessary amendments were made based on the experts' and arbitrators' opinions, resulting in the pre-final form of the cognitive test, consisting of 30 single statements. The test was corrected by assigning one point for each correct answer and zero for incorrect answers. The total score was 30, and a test correction key was prepared. The final version of the cognitive achievement test was established, consisting of 30 questions, after incorporating the experts' and arbitrators' feedback. To analyze the test items, a representative sample of individuals from the original sample was selected to calculate the ease and difficulty coefficients. The test was administered to a sample of 20 students, and the ease coefficients ranged from 0.67 to 0.32, while the difficulty coefficients ranged from 0.68 to 0.34. These coefficients indicate the suitability of the test to the sample members' level. The discrimination coefficient for the test items was calculated using the variance, which is the product of the ease factor and the difficulty factor. The test variance ranged from 0.21 to 0.26, suggesting that the test can be used as a tool to evaluate cognitive achievement. Calculating the average test-taking time between the first and last students allowed for the determination of the test's duration. The test duration was determined to be 20 minutes.

2.2.3. Proposed Brochure with QR Code (see Appendix D)

The researcher has developed a model consisting of five key stages: Goal Setting Stage: The objective of this research is to examine the impact of a proposed booklet, equipped with quick response codes (QR codes), on the learning outcomes of the gymnastics course in terms of selected skills and cognitive achievement. The proposed booklet aims to enhance learning by providing access to additional digital resources through QR codes. Analysis Stage: a) Determining Learners' Characteristics: The research sample was selected from students at the College of Physical Education and Sports Sciences at Hashemite University. It was identified that all participants in the sample own smartphones and have internet access. b) Determining Educational Content: The researcher reviewed the educational content of the gymnastics course based on the course description. The content included in the proposed booklet was determined as follows: an overview of the historical development of gymnastics, relevant articles on gymnastics regulations, and practical skills such as forward rolling, back rolling, and handstand.

Design and Production Stage: QR codes were designed and produced through the following steps: A. Identifying Digital Sources: The researcher identified various digital sources that support the booklet and the topics covered, aiming to enhance students' achievement in the skills under study. These sources include still and moving images of the skills, videos demonstrating technical and educational steps for the skills, and texts and videos on the theoretical aspects of the educational content. B. Building Codes: The researcher uploaded the digital sources to Google Drive (https://drive.google.com) to obtain links. These links were then used to generate QR codes using dedicated QR code creation and design websites such as https://qrcodefree.online/#skype and https://www.qrgenerator.com. Evaluation Stage: A group of experts in the fields of gymnastics, educational technology, and teaching curricula and method evaluated the proposed booklet along with the QR codes. Educational Method and Teaching Strategy:

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For the students in the experimental group, the researcher used a self-directed learning strategy and the suggested booklet supported by QR codes.

2.3. Research Timeline

Before commencing the program, the control and experimental research groups underwent homogeneity and parity tests in terms of growth rates, intelligence, physical abilities, cognitive achievement, and the gymnastics skills under study (front roll, back roll, handstand). The research tools were subjected to scientific validity and reliability coefficients. Pre-measurements were conducted for all research variables in both groups. The educational program was implemented over eight weeks, with each educational unit lasting 120 minutes, as per college regulations. Within the lecture, there was a designated time of 30 minutes for watching the educational program on the computer. The organizational structure of the lecture for the experimental group was as follows: administrative work (5 minutes), warm-up and physical preparation (20 minutes), watching and interacting with the booklet (30 minutes), the main practical application (60 minutes), and conclusion (5 minutes). For the control group, the 30 minutes allocated for viewing time were replaced with an explanation of the method of performing the learned skill and a model for it. An exploratory study was conducted from March 26, 2023 to April 9, 2023 on a sample of 20 students from the same research community but outside the original sample. The aim was to obtain scientific parameters for the data collection tools. The pre-measurements for the experimental and control groups, including intelligence tests, cognitive achievement tests, and physical and skill tests, were conducted from April 10, 2023 to April 13, 2023.

The main experiment for the experimental group took place from April 16, 2023, to April 22, 2023, while for the control group, it was conducted from April 17, 2023, to June 22, 2023. A preliminary meeting was held with the research participants to introduce them to the nature of the research and the tasks assigned to them after each session. It was ensured that all sample members had smartphones and internet access. A brief presentation was conducted to explain the concept and functioning of QR codes, as well as to provide the names of some Android applications for scanning QR codes. The participants were instructed to download a QR code reader program from the Play Store on their smartphones. They were then given a sheet containing various forms of QR codes to scan using the downloaded program, ensuring their proficiency in using the program and scanning QR codes easily, as well as confirming their internet access. The proposed booklet, along with the printed QR codes (Appendix C) and a guideline for using the booklet (Appendix D), was distributed to each participant. After the program implementation period, post-measurements were conducted for both the experimental and control groups in the tests used, from June 25, 2023 to June 26, 2023.

2.4. Statistical Analysis

Statistical analyses were conducted using the Statistical Package for the Social Sciences (SPSS) software (IBM SPSS Statistics 26.lnk, Chicago, IL, USA). Statistics analyses, including the mean and standard deviation, were calculated. To assess the significance of the results, t-test analysis, Cohen's d-effect size, and the change ratio were utilized. The significance level was set at $p < 0.05$.

3. Results

Table 2 presents the pre- and post-measurement results for the variables, along with Cohen's d effect size, t-value, and improvement rate. Cognitive Achievement: The mean score significantly increased from 12.73 (pre) to 27.40 (post), with a large effect size of 7.12. The t-value of 27.59 indicates a significant improvement. The improvement rate for cognitive achievement was 53.54%. Skills: Forward Roll: The mean score showed a significant increase from 2.83 (pre) to 8.33 (post), with a large effect size of 5.82. The t-value of 22.54 indicates a significant improvement. The improvement rate for the forward roll skill was 66.03%. Back Roll: The mean score significantly increased from 2.73 (pre) to 7.93 (post), with a large effect size of 5.76. The t-value of 22.32 indicates a significant improvement. The improvement rate for the back roll skill was 65.57%. Handstand: The mean score significantly

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increased from 2.08 (pre) to 6.83 (post), with a moderate effect size of 4.36. The t-value of 16.87 indicates a significant improvement. The improvement rate for the handstand skill was 69.55%. These results indicate that the use of technology, specifically the proposed booklet with QR codes, had a positive impact on cognitive achievement and the development of gymnastics skills. The improvement rates demonstrate substantial progress in these areas.

Table 2.
The significance of the differences between the pre-and post-measurements for the variables in the experimental group (n= 15).

Variables		Measuring unit	Pre		Post		t- value	Cohen's d	Imp. rate
			Mean	Std.	Mean	Std.			
Cognitive achievement		Score	12.73	1.49	27.40	1.40	27.59	7.12	53.54%
Skills	Forward roll	Score	2.83	0.45	8.33	0.72	22.54	5.82	66.03%
	Back roll	Score	2.73	0.46	7.93	0.80	22.32	5.76	65.57%
	Handstand	Score	2.08	0.25	6.83	0.99	16.87	4.36	69.55%

The results presented in Table 2 show the differences between the pre-and post-measurements for the variables in the experimental group, consisting of 15 participants. For cognitive achievement, there is a significant increase in the mean score from 12.73 (pre-test) to 27.40 (post-test). The calculated t-value of 27.59 indicates a highly significant difference. Cohen's d value of 7.12 suggests a large effect size. The improvement rate is 53.54%, indicating a substantial enhancement in cognitive achievement. Regarding gymnastics skills, there are significant improvements in all three skills measured. The mean scores for forward roll, back roll, and handstand show substantial increases from the pre-test to the post-test. The calculated t-values (22.54, 22.32, and 16.87) indicate highly significant differences for each skill. Cohen's d values (5.82, 5.76, and 4.36) suggest large effect sizes for all skills. The improvement rates are 66.03% for forward roll, 65.57% for back roll, and 69.55% for handstand, indicating significant progress in all three gymnastics skills. Overall, these results demonstrate that the intervention implemented in the experimental group, which involved the use of QR Code technology, had a positive and significant impact on cognitive achievement and the development of gymnastics skills.

Table 3.
The significance of the differences between the pre-and post-measurements for the variables in the control group (n= 15).

Variables		Measuring unit	Pre		Post		t- value	Cohen's d	Imp. rate
			Mean	Std.	Mean	Std.			
Cognitive achievement		Score	12.53	1.13	17.27	1.39	13.22	3.41	27.45%
Skills	Forward roll	Score	3.00	0.46	4.87	0.74	18.67	4.82	38.40%
	Back roll	Score	2.87	0.30	4.73	0.70	10.10	2.61	39.32%
	Handstand	Score	1.97	0.32	3.80	0.78	8.27	2.14	48.16%

Table 3 presents the significance of the differences between the pre-and post-measurements for the variables in the control group. For the variable "cognitive achievement score," there was a significant increase from a mean of 12.53 (SD = 1.13) in the pre-measurement to a mean of 17.27 (SD = 1.39) in the post-measurement. The t-value of 13.22 indicates a highly significant difference, and the effect size (Cohen's d) of 3.41 suggests a large effect. The improvement rate for this variable was 27.45%. Regarding the variable "forward roll score," there was a significant improvement from a mean of 3.00 (SD = 0.46) in the pre-measurement to a mean of 4.87 (SD = 0.74) in the post-measurement. The t-value

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of 18.67 indicates a highly significant difference, and the effect size of 4.82 suggests a large effect. The improvement rate for this variable was 38.40%. Similarly, for the variables "back roll score" and "handstand score," there were significant increases in the post-measurements compared to the pre-measurements. The t-values of 10.10 and 8.27, respectively, indicate highly significant differences. The effect sizes of 2.61 and 2.14, respectively, suggest large effects. The improvement rates for these variables were 39.32% and 48.16%, respectively. Overall, the results indicate that the control group showed significant improvements in cognitive achievement and various skills after the intervention.

Table 4.
The significance of the differences between the post-measurements for the variables in the experimental and control group (n= 15).

Variables		Measuring unit	Experimental (n= 15)		Control (n= 15)		t-value	Cohen's d	Differences in imp. rate
			Mean	Std.	Mean	Std.			
Cognitive achievement		Score	27.40	1.40	17.27	1.39	19.88	5.13	26.09%
Skills	Forward roll	Score	8.33	0.72	4.87	0.74	12.94	3.34	27.63%
	Back roll	Score	7.93	0.80	4.73	0.70	11.64	3.01	26.25%
	Handstand	Score	6.83	0.99	3.80	0.78	9.32	2.41	21.39%

Table 4 provides the significance of the differences between the post-measurements for the variables in the experimental and control groups. For the variable "cognitive achievement score," the experimental group had a significantly higher mean of 27.40 (SD = 1.40) compared to the control group's mean of 17.27 (SD = 1.39). The t-value of 19.88 indicates a highly significant difference, and the effect size (Cohen's d) of 5.13 suggests a large effect. The improvement rate for the experimental group was 26.09% higher than the control group. Regarding the variable "forward roll score," the experimental group had a significantly higher mean of 8.33 (SD = 0.72) compared to the control group's mean of 4.87 (SD = 0.74). The t-value of 12.94 indicates a highly significant difference, and the effect size of 3.34 suggests a large effect. The improvement rate for the experimental group was 27.63% higher than the control group. Similarly, for the variables "back roll score" and "handstand score," the experimental group had significantly higher means compared to the control group. The t-values of 11.64 and 9.32, respectively, indicate highly significant differences. The effect sizes of 3.01 and 2.41, respectively, suggest large effects. The improvement rates for the experimental group were 26.25% and 21.39% higher than the control group for these variables. Overall, the results indicate that the experimental group outperformed the control group in terms of cognitive achievement and various skills. The experimental group showed significantly higher scores and larger improvements compared to the control group. The differences in improvement rates highlight the effectiveness of the intervention in enhancing the learning outcomes for the experimental group compared to the control group.

4. Discussion

The results from Table 2 indicate that there are significant differences between the average scores of the pre-and post-measurements of the experimental group in gymnastics skills and cognitive achievement in the gymnastics course being studied. These differences favor the post-measurement, as all the calculated t-values are greater than the tabulated t-value at the significance level of 0.05. This suggests that the proposed booklet, which the quick response code supports, has a positive effect on the course's cognitive achievement and the development of gymnastics skills. The researcher attributes the progress observed in the experimental group's learning of gymnastics skills to the integration, comprehensiveness, organization, and good arrangement of the content in the booklet program. The

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booklet contains numerous quick response codes that provide technical stages, educational steps, and carefully selected videos and pictures to facilitate learning the skills interestingly and engagingly. The use of this technology allows for easy access, viewing, and repetition of the content, as well as the ability to focus on specific parts that require further review and understanding. The use of QR code technology creates a new educational environment that stimulates students' senses and motivates them to actively participate in the learning process, leading to a better understanding of the correct methods of performing skills. The findings align with previous studies that have demonstrated the positive outcomes of using QR codes in teaching and learning. These codes have been utilized to create informative materials, conduct surveys and tests, supplement textbook content, and provide support for various subjects [11]. They have been shown to enhance student interest in learning, foster teamwork skills, and broaden cultural perspectives, thereby promoting the development of global competencies [12]. QR codes have been widely implemented in educational institutions, including universities and colleges, to enhance the effectiveness of teaching and learning processes [13].

The results presented in Table 3 demonstrate significant differences between the pre-test and post-test means for the control group in terms of cognitive achievement and the acquisition of gymnastics skills. The calculated t-value exceeds the tabulated t-value at a significance level of 0.05. This suggests that the traditional method employed in the control group, involving explanation and model performance, has a relatively positive impact on cognitive achievement and the acquisition of gymnastics skills. The researcher attributes this result to the fact that the traditional method relies on verbal explanations and demonstrations by the teacher, which helps learners understand the motor sequences of the skills being taught. The regularity and continuity in learning and practice, along with the teacher providing a series of progressively challenging exercises, provide learners with a favorable opportunity to acquire the skills being studied. This, in turn, positively impacts the efficiency of skill performance. Traditional educational methods have been recognized as effective in improving education [14]. They are considered enduring ideas that continue to yield positive outcomes in educational systems [15]. While there is a growing emphasis on incorporating innovative approaches, researchers emphasize the importance of preserving pedagogical traditions to achieve important positive outcomes in education [16]. Some researchers even argue that traditional education may be more effective than innovative education [17]. Overall, the results indicate that traditional methods play a significant role in the educational process and should not be disregarded [18]. The results of Table 4 indicate that there are statistically significant differences between the average scores of the post-measurements of the experimental and control groups in cognitive achievement and learning gymnastics skills. As all calculated t values are greater than the tabulated t value at a significance level of 0.05. Which indicates that the proposed booklet, supported by QR Code technology has a positive impact on the cognitive achievement and gymnastics skills under study? The researcher attributes the progress made by the experimental group in terms of cognitive achievement and the studied skills to the use of the proposed booklet supported by the QR code. This approach saves students time and effort in the learning process. The QR code helps build a new cognitive structure for students by providing new experiences and modifying existing ones. The process of students obtaining information themselves and discussing it with their peers and the teacher increases their motivation and presents educational material logically and sequentially, taking into account individual differences. The booklet includes various activities that are easy for students to engage with, multiple options and alternatives for research and learning, and provides feedback to encourage and motivate students, thus positively impacting their achievement.

Studies have shown that QR codes are widely used in the education industry to make teaching and learning more effective [12]. QR codes have also been found to be effective in enhancing extensive reading, particularly in helping learners comprehend culture-specific terms and improving their overall reading experience [19]. According to the study by Jassim, using QR codes for special exercises improved cognitive speed and the acquisition of fundamental artistic gymnastics skills [20]. Another study by Meyers et al. examined the effectiveness of different sets of instructions on the acquisition of gymnastics skills and found that appropriate self-instructional behavior, including the use of QR codes,

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facilitated gymnastics performance [21]. The booklet presents educational content in an interesting and organized manner, allowing students to replay and watch skill videos multiple times, which increases their achievement rate and comprehension of difficult parts and unclear steps. The use of pictures, drawings, videos, and colors stored within the QR code attracts students' attention and increases their excitement to follow, retain, and retrieve information when applying the skills in practice. This helps students form a complete mental and motor perception of the skill. The engaging learning environment that video clips, colors, and texts create makes it easier for students to learn and master the studied skill quickly, which improves their ability to absorb and comprehend new knowledge and information. Additionally, the use of QR codes saves time and effort. These findings align with previous studies that have shown the benefits of using QR codes in teaching and learning. QR codes offer advantages such as fast reading speed, error correction, multi-language support, and durability [11, 22]. They have been utilized in various ways, including creating educational materials, conducting surveys and tests, expanding textbook content, and supporting the study of different subjects [12, 13]. Research has demonstrated that the use of QR codes in the classroom can increase interest in learning, develop teamwork skills, and improve learning outcomes [23]. Thus, the research hypotheses have been achieved.

5. Conclusions

The objective of this study was to evaluate the impact of a QR Code-supported booklet on cognitive achievement and the acquisition of gymnastics skills, specifically front ball roll, back ball roll, and handstand. A total of 30 students participated in the study, and the results demonstrated significant disparities between the experimental and control groups in terms of cognitive achievement scores. The experimental group exhibited a significantly higher average score of 27.40 (SD = 1.40) compared to the control group's average score of 17.27 (SD = 1.39). The calculated t-value of 19.88 indicated a highly significant difference, with a large effect size (Cohen's d) of 5.13. Additionally, the experimental group demonstrated a 26.09% higher improvement rate compared to the control group. Similarly, for the variables of forward roll, back roll, and handstand scores, the experimental group displayed significantly higher mean scores compared to the control group. The t-values of 12.94, 11.64, and 9.32, respectively, indicated highly significant differences between the groups. The effect sizes of 3.34, 3.01, and 2.41, respectively, indicated large effects. The improvement rates for the experimental group were 27.63%, 26.25%, and 21.39% higher than the control group for these variables. Overall, the findings suggest that the experimental group outperformed the control group in terms of cognitive achievement and the acquisition of various gymnastics skills. The experimental group exhibited significantly higher scores and greater improvements compared to the control group. The differences in improvement rates highlight the effectiveness of the QR Code-supported booklet intervention in enhancing learning outcomes for the experimental group. The researcher proposes conducting future studies that focus on investigating the impact of using an improved booklet with a QR code on students' knowledge and skill learning outcomes. These studies can explore various aspects, including Comparing the effectiveness of using the improved booklet with a QR code to traditional teaching methods in developing students' critical and analytical skills. Conduct a longitudinal study to examine the long-term effects of using the improved booklet with a QR code on students' knowledge retention and skill development over an extended period. Investigate the effect of providing teachers with training and guidance on effectively utilizing the improved booklet with a QR code to enhance students' critical thinking and analytical skills. Employ a mixed-methods approach to gather both quantitative and qualitative data, allowing for a comprehensive understanding of the impact of the improved booklet with a QR code on students' knowledge and skill learning outcomes. Explore the transferability of knowledge and skill learning outcomes across different academic disciplines by using the improved booklet with a QR code in various subject areas. Conduct a meta-analysis of existing studies to synthesize the findings and determine the overall effect size of using the improved booklet with a QR code on students' knowledge and skill learning outcomes. By conducting these future studies, researchers can contribute to a better

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understanding of how the use of an improved booklet with a QR code can effectively enhance students' knowledge and skill learning outcomes. This knowledge can provide valuable insights for teachers, policymakers, and decision-makers in the field of education.

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The Ethical Committee of the King Faisal University, Saudi Arabia has granted approval for this study (Ref. No. KFU-REC-2023-JUN-ETHICS1872).

Transparency:
The author confirms that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

Competing Interests:
The author declares that there are no conflicts of interests regarding the publication of this paper.

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Figure 1 illustrates the mean, standard deviation, and percentage of improvement for the pre- and post-measurements of the experimental group in the variables.

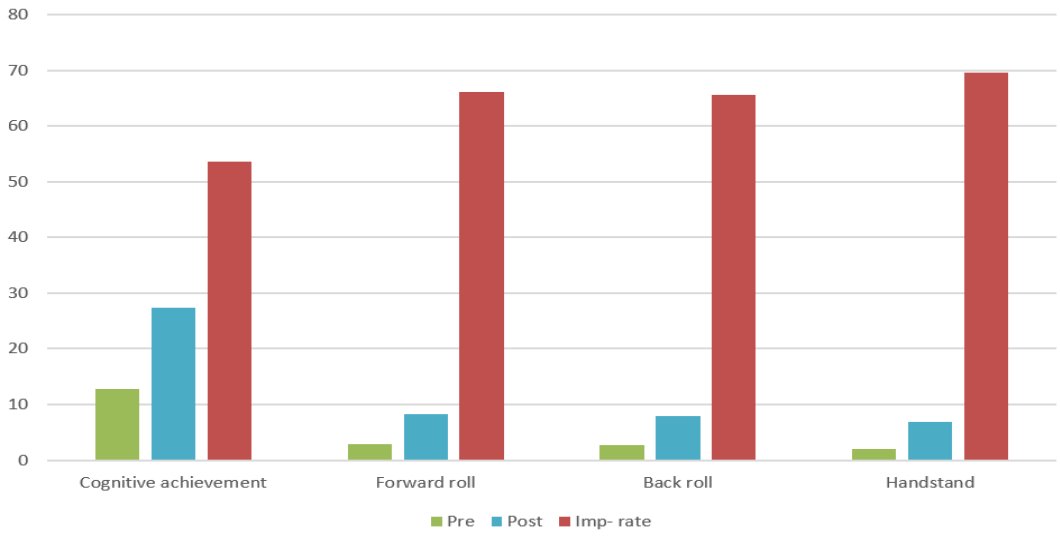

Figure 1.
Displays the mean and percentage of improvement for the pre- and post-measurements of the experimental group.

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Figure 2 illustrates the mean, standard deviation, and percentage of improvement for the pre- and post-measurements of the Control group in the variables.

Figure 3 Illustrates the mean, standard deviation, and percentage of improvement for the post-measurements of the experimental and control group in the variables.

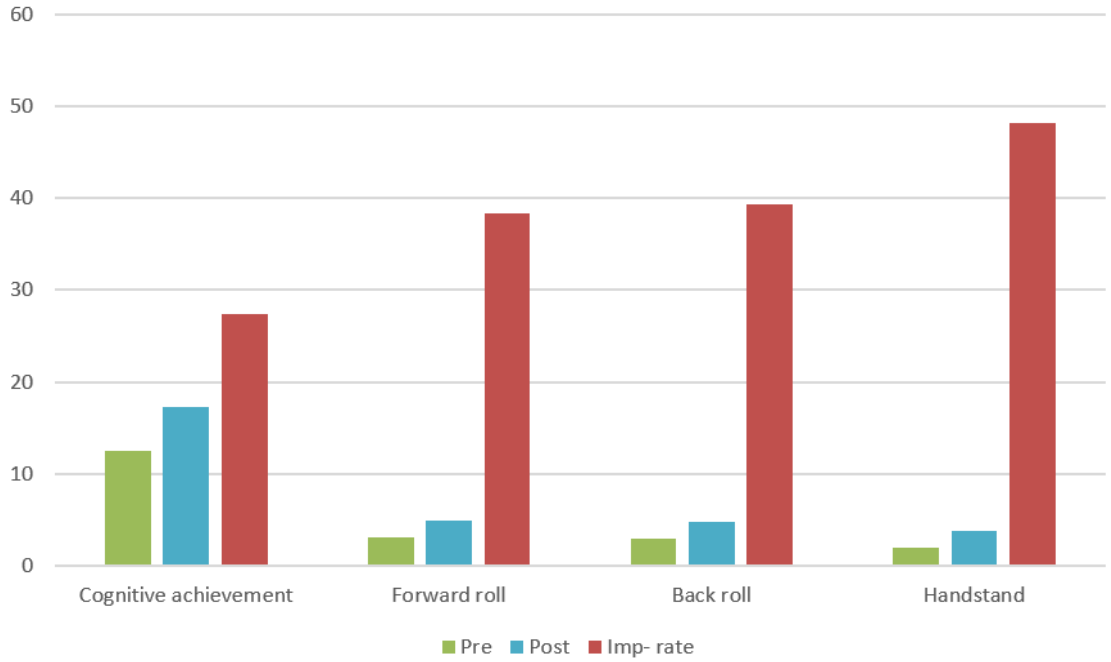

Figure 2.
Displays the mean and percentage of improvement for the pre- and post-measurements of the control group.

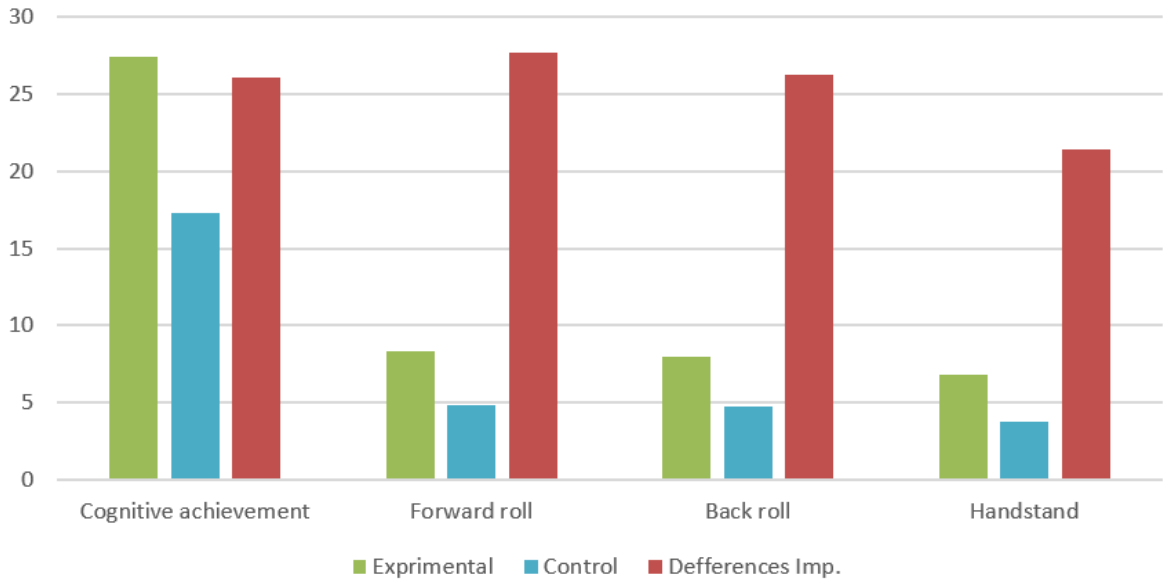

Figure 3.
Displays the post-measurements of the experimental and control groups in the variables.

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Supplementary Materials:

Appendix A: This appendix includes separate units for both the experimental group and the control group (see Table S1).

Appendix B. Performance Appraisal Form for Gymnastics Skills: The researcher designed a performance evaluation form for gymnastics skills (front rolling balls - rolling back curled - standing on the hands) under research for his sample research has followed the researcher when designing the form, the following steps:

- Determine the purpose of the card:In light of the objective of the research, the objective of the questionnaire was determined, which is to evaluate the performance of gymnastics skills (front rolling - back rolling - handstand) under research.
- Determine the score of each skill:After determining the objective of the form, the researcher presentedit in its initial form to the experts in the field of gymnastics to determine the degree of each skill of gymnastics skills (front rolling ball - rolling back ball - stand on the hands) under research, and the researcher reached after polling the opinions of experts to the final image of the performance evaluation form to be the degree of each skill (10 degrees). The performance of the sample under research was evaluated by a committee consisting of (3) three arbitrators from experts in the field of gymnastics, provided that the final score for each skill is calculated by calculating the average of the total scores of the three arbitrators (see Table S2).

Appendix C: Cognitive Achievement Test: This appendix includes a collection of questions specifically designed to assess cognitive achievement in the domain of gymnastics skills.

Appendix D: QR Code Supported Booklet for Gymnastics Skills: This appendix presents the proposed booklet that incorporates QR codes specifically related to gymnastics skills.

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Table S1.
A sample module for the experimental group using the proposed handbook supported by a QR code.

No.	Lesson parts	Time	Content	Behavioral goals	Devices and tools
1	Administrative work	5 s	• Change clothes – taking absences	• Students should get used to the system and implement the teacher's orders.	
2	Warm-up and physical preparation	20 s	• Running around the floor mat and when hearing the teacher's signal, students take a standing position opening their hands on the ground in front of the body. • Speed: (Standing) running in place • Flexibility: (Standing, arms high) bend the torso front down • Compatibility: (Standing) jumping inside the numbered hoops. • Strength: (Standing - arms high, holding a medical ball) bend and extend the arms. • Agility: (Standing) running Zigzaji between cones. • Ability: (Standing) jumping feet forward and backward.	• To prepare students physically to serve the skill activity. • Students acquire some elements of physical fitness.	• Hall.- floor mat movements. • Collars.- Medical balls .- Cones.
3	View brochure	30 s	• Watch the skill of front rolling and interact with it using the proposed booklet supported by a quick response code	Students learn how to perform the skill of front rolling and interact with the proposed booklet supported by a QR code in the hall	• Mobile devices. • Proposed brochure
4	Apply skills	60 s	• Students apply the practical skill of front rolling according to what they saw, interacted with and learned through the proposed booklet supported by the rapid response code.	• Students acquire the method of performing the skill of rolling the front rolling	• Hall.- floor mat movements.
5	Conclusion	5 s	• (Standing) vertical weighted. • (Standing) side-weighted. • Gathering and leaving.	• Students get used to performing some calming exercises. • Students get used to taking completeness and leaving.	• Hall.- Floor carpet

Note: Unit: First, week: First, general objective: Developing the elements of physical fitness and providing skill aspects. Special goal: Learn the skill of rolling the front ball in gymnastics. Time: 120 s.

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Table S1.
Continue.

No.	Lesson parts	Time	Content	Behavioral goals	Devices and tools
1	Administrative work	5 s	• Change clothes – taking absences	• Students should get used to the system and implement the teacher's orders.	
3	Warm-up and physical preparation	20 s	• Running around the floor mat and when hearing the teacher's signal, students take a standing position opening their hands on the ground in front of the body. • Speed: (Standing) running in place. • Flexibility: (Standing, arms high) bend the trunk in front of the bottom. • Compatibility: (Standing) jumping inside the numbered hoops. • Strength: (Standing - arms high, holding a medical ball) bend and extend the arms. • Agility: (Standing) running Zigzaji between cones. • Ability: (Standing) jumping feet forward and backward.	• To prepare students physically to serve the skill activity. • Students acquire some elements of physical fitness.	• Hall - Ground carpet. • Hoops - Medical balls.- Cones.
4	Explanation and model performance	30s	• The skill of rolling the front ball • Explain the method of performance. • Performance of a skill model	• Students should benefit cognitively from the teacher's explanation of the method of performing the skill. • Students should watch and learn to perform the skill of rolling the front ball.	• Hall - Floor Mat
5	Apply skills	60 s	• The students implement the method of performance based on what is heard and witnessed to perform the practical model of the skill of rolling front ball ball by the teacher.	• Students acquire the method of performing the skill of rolling the front rolling	• Hall. - Floor carpet
6	Conclusion	5 s	• (Standing) vertical weighted. • (Standing) side-weighted. • Gathering and leaving.	• Students get used to performing some calming exercises. • Students get used to taking completeness and leaving.	• Hall. • Ground carpet.

Note: Unit: First, week: First, general objective: Developing the elements of physical fitness and providing skill aspects. Special goal: Learn the skill of rolling the front ball in gymnastics. Time: 120 s

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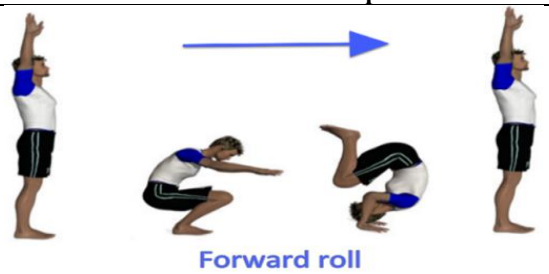
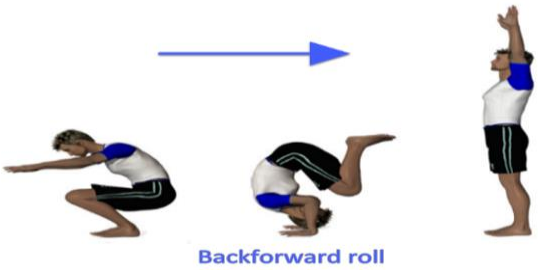
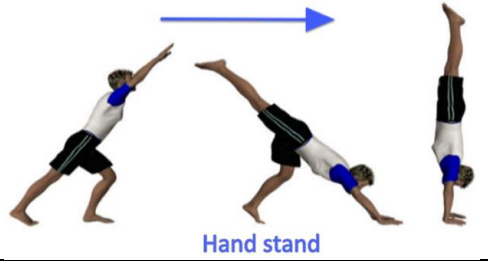
Table S2.
Performance appraisal form for gymnastics skills under research (Front rolling - rolling back - standing hands).

Skill name	Performance specifications	Grade	Form of performance
Front rolling pellets forward roll	Sitting on all fours, hands with wide shoulders, tilting the body forward with the arms bent and the head bending to the chest, and the student pushes the ground with the feet with the knees bent on the chest and holding them with the arms, then touching the ground starting from behind the neck and to the shoulders, torso and hip until the player returns to standing, bending the knees and arms in front of him.	10 degrees	
Rear rolling pellets backward roll	From a standing position, bending the torso down, resting on the hands on the floor, rolling the body backwards with the body stretched, rapid thrust and arms to reach a handstand position, the body straight.	10 degrees	
Handstand hand stand	From a standing position, arms high, the player moves the body on the front leg and places the hands on the ground with a wide chest, then swings the free leg upwards with the ground pushed with the fulcrum leg and swinged behind to join the legs to reach the vertical fulcrum position inverted the body on one straight.	10 degrees	

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