
The Effect of Virtual Reality (VR)-Assisted Exercises on Developing and Learning Certain Mental Abilities and Floor Exercise Skills in Artistic Gymnastics among Students

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ABSTRACT

Background: The purpose of this research is to explore the influence of exercises performed in virtual reality on the formation of some specific cognitive and motor skills, and on floor exercises techniques in artistic gymnastics in students, and to find differences between training programs that use virtual reality and conventional ones.

Methods: Experimental design has been used as the design of this study because of its correspondence to the study objectives. The sample consisted of 26 male students from Al-Jihad Preparatory School for Boys, Kirkuk Directorate of Education, and divided randomly into two equal groups; an experimental group and a control one, each consisted of 13 students. The experimental group had participated in an instructional program assisted with Virtual Reality (VR), while the other had followed traditional instructional program.

Results: The data have been gathered using motor performance evaluation form, systematic observation, personal interview and video recording to test technical performance. Results showed a significant improvement from pre- to post-test in the learning of the selected artistic gymnastics skills, as well as statistical significance between post-tests of the two groups in favor of the experimental group. The authors explained such results due to the interactive environment provided by virtual reality, where visualization of technical performance, attention, involvement, and motivation towards learning are improved.

Conclusions: Virtual Reality (VR)-assisted training programs significantly improve cognitive-motor skills and basic floor exercises techniques skills in artistic gymnastics compared to conventional programs.

Keywords: Virtual Reality (VR); Floor Exercises; Cognitive-Motor Skills; Artistic Gymnastics.

INTRODUCTION

What distinguishes the current era from others is the great advances in the field of technology in different sectors of the society. The emphasis here is on physical education and sports. Along with such developments, the modern innovations of technology like television, projector and video device, and computer have become determining factors in the educational process, as they contribute to the success of the latter and to its effective implementation. Moreover, the perspectives of such an approach also include the roles of the student, the teacher, and the curriculum of education along with its parts and aids, and how such aids are used in the instruction process in order to help individuals develop new motor skills (Al-Tikriti, 1997, p. 27).

The advancement of science which applies to all the spheres of life including sports, was adopted by many countries in the world and did not happen accidentally. On the contrary, the development of such countries is based on a number of principles, the most important of which is the adoption of the principles and foundations of scientific research. Since sports is a part of life and reflects the level of development and advancement of any society through developing individuals both mentally, physically, and motorically, the achievement of such goals in the shortest period of time and at minimum costs requires the use of educational technologies. Specifically, artistic gymnastics is a sport which implies strict demands and rules, and includes various physical, motor, mental, and psychological factors. The importance of the application of educational software in the development of motor skills is that it provides learners with enough time to learn the steps of skill implementation with the help of visual representation of all the elements of the skill. Moreover, it provides feedback for positive actions (Al-Jilani, 2003, p. 226).

Mental ability is a concept that was introduced in France towards the end of the nineteenth century and the beginning of the twentieth century in connection with the evaluation of intelligence. Later on, the idea of mental ability was elaborated upon by Charles Spearman who did away with the idea of intelligence owing to its broad definition and used the idea of general factor instead. The general factor is one's mental power and is connected with the left side of the brain. Mental ability refers to the ability of a person to produce a reaction which involves motor skills and cognitive problem-solving. This is also one's ability to do something and adapt to a particular situation through sensory or mental activities. These abilities may be natural or learned abilities. There are also general abilities that form a common factor that is shared to some extent by different abilities (Kasoub, 2020, p. 211).

The basic concept behind Virtual Reality technology is the sense of immersion created by the artificial environments. The immersion process is a consequence of the interrelation of three factors, namely perception illusion, creation of three-dimensional images, and the reaction of the virtual environment to movement of the head, eyes, body, arms, and fingers. In this manner, learning barriers are overcome easily in the process. Moreover, virtual reality makes it possible to perform spatial navigation and, figuratively speaking, travel back in time to previous eras or ahead into future time, or both together, which is called temporal blending.

Research Problem

Based on field experience gained in gymnastics education, the study identifies that the main means of teaching skills include live demonstration, verbal description, repetition, and error correction. Such teaching process might have effects on learners' psychological, physical, and skills statuses. In this regard, the researchers sought to use the modern technology in order to improve cognitive and motor competencies needed for different types of sports, such as artistic gymnastics. The term 'artistic gymnastics' includes a variety of different exercises and skills of different difficulty and the students should change them while maintaining optimum performance.

At the same time, the researchers observed that the teacher-oriented teaching approach is still dominating and it is extensively used. Although it is not absolutely useless, modern developments – informational expansion and fast progress in technologies, – increase difficulties of the

educational process in ways that cannot be solved only with the help of teacher-centered methodology. There are many reasons why such a situation happens – lack of resources, educational and social environment, presentation of the instruction material, and other issues. Thus, the researchers attempted to solve this problem and explore its practical aspect with the help of VR environment to develop and obtain certain cognitive competencies and floor exercise skills in artistic gymnastics at Al-Jihad Preparatory School for Boys.

Research Objectives

1. To create exercises with Virtual Reality (VR) aimed at improving particular mental abilities and helping learn particular floor exercise skills in artistic gymnastics.
2. To assess the effect of immersive Virtual Reality (VR) on the development of certain mental abilities and on the learning of certain floor exercise skills in artistic gymnastics.
3. To identify the difference between using Virtual Reality (VR) and teaching technique employed by the teacher in the development of certain mental abilities and in learning certain floor exercise skills in artistic gymnastics.

Research Hypotheses

1. There are statistically significant differences between the pre-test and post-test results of the two research groups (control and experimental) in developing certain mental abilities and learning selected floor exercise skills in artistic gymnastics among students, in favor of the post-test results.
2. There are statistically significant differences between the post-test results of the two research groups (control and experimental) in developing certain mental abilities and learning selected floor exercise skills in artistic gymnastics among students, in favor of the experimental group.

Research Domains

Human Domain:

Subjects: Students attending Al-Jihad Preparatory School for Boys under the Kirkuk Directorate of Education for the academic year of 2025-2026.

Time Domain:

Period: From October 26, 2025 to March 15, 2026.

Space Domain:

Place: Sports Activity Hall, Kirkuk Directorate of Education.

Definition of Terms

Virtual Reality (VR)

created inside the memory of the computer system, leading to a condition of total presence and providing another horizon of human existence.

VR works through transporting human consciousness into the virtual world created using digital technology, allowing the consciousness of the human being to dive into the manifestation of imagination (Haidi, 2009).

It can also be defined as software that creates three-dimensional imaginary worlds where people can create avatars to depict themselves and build and design buildings and three-dimensional objects and do many other things and even interact with people in distant parts of the world (Al-Sayed, 2014, p. 124).

METHODS

Research Method

In this case, an experimental method was used, considering that it was the most appropriate method to conduct the research. The main advantage of using the experimental method of research is the possibility to regulate several variables.

Research Population and Sample

The research population has been selected on purpose and was made up of students studying at Al-Jihad Preparatory School for Boys, Kirkuk Directorate of Education, for the 2025–2026 academic year. The research population comprised two classes including 60 students. The research sample was selected randomly from Classes A and B and consisted of 26 students that have been divided into the experimental group and the control group of 13 students each.

The following criteria were used to exclude several students: 7 students have repeated the grade; 10 students had practiced this activity earlier; 11 students missed pre-test due to the absence when recording their technical performance on video; 11 students did not answer the questionnaire; 5 students missed more than two lessons during the experiment.

Thus, the research sample includes 26 students with 13 in the experimental group and 13 in the control group comprising 43.33% of second-year students. Table 1 shows the research sample and criteria for excluding several students.

Table 1. Research Sample and Reasons for Exclusion

Class	Nu mb er	Absent from Pre- test	Grade Repetiti on	Prior Experi ence	Absent from Classes	Incomplete Questionna ire	Absent from Post-test	Total Exclu ded	Final Samp le	Percent age
A	29	6	3	4	3	5	–	21	13	48.33%
B	31	5	4	6	2	6	–	23	13	51.67%
Total	60	11	7	10	5	11	–	44	26	43.33%

The researchers also established homogeneity among the main and pilot samples with respect to the variables measured, as presented in Table (2).

Table 2. Descriptive Statistics and Homogeneity of the Research Sample

No.	Variable	Unit of Measurement	Mean	Standard Deviation	Skewness Coefficient
1	Body Mass	kg	65.5833	4.08327	–0.286
2	Height	cm	172.0833	6.69419	0.114
3	Age	years	19.7500	0.45227	–0.621

Data and Information Collection Methods and Supporting Tools

1. Arabic and foreign sources.
2. Motor Performance Assessment Form.
3. Observation.
4. Personal interviews.

Instruments Used in the Research

1. Samsung video camcorders: 3 in numbers.
2. VR headsets: 20 in numbers.
3. Stopwatches: 4 in numbers.
4. Foam mats: 20 in numbers.
5. Hewlett Packard laptop computers: 2 in numbers.
6. Magnetic disks: 10 in numbers.

Pilot Study

As part of a pilot study, the applicability and efficacy of the tools, researchers, and methods of measurement used in the upcoming study were tested. This is highly recommended in science because it acts as an experiment or trial before conducting the main study (Qasim Hassan et al., 2022).

This pilot study took place on December 1, 2025, at 11:00 a.m. with the following purposes:

1. The determination of proper camera positioning and camera height.
2. The determination of the number of people needed in the assisting team.

3. The evaluation of the adequacy and preparedness of the tools and equipment to be used during the experiments.

Scientific Foundations of the Tests Used

Validity

The face validity of the tests selected (forward roll, handstand, and cartwheel) was confirmed through expert judgement, as previously mentioned. Furthermore, the self-validity of these tests was determined from the equation:

$$\text{Self-validity} = \sqrt{\text{Reliability coefficient}}$$

The results are presented in Table (3).

Reliability

In order to check the reliability of selected tests (forward roll, handstand, and cartwheel), the tests were given to 13 sample subjects on December 5, 2025, and were conducted again to the same sample subjects on December 10, 2025. These results are shown in Table (3).

Objectivity

The objectivity was checked through conducting the tests on the pilot study sample of 13 subjects and obtaining the result from two judges independently. Then the Pearson correlation coefficient was calculated between the scores of these judges. It resulted in a very high value showing that the tests have a high degree of objectivity. The scientific bases of selected tests are provided in Table (3).

Table 3. Validity, Reliability, and Objectivity Coefficients

N o.	Test	First Administrati on Mean	SD	Second Administra tion Mean	SD	Reliability Coefficient	Self- Validity	Object ivity
1	Forward Roll, Handstand, and Cartwheel	5.700	0.581	5.783	0.642	0.836	0.914	0.958

Main Experiment

The instruction program for both the experimental and control groups started from Sunday, December 17, 2025. This includes two instructional units every week for both groups. The instruction program was carried out by the researcher in order to assist the students in both groups to acquire selected skills of artistic gymnastics at the Sports Activity Hall, Kirkuk Directorate of Education.

Both groups followed the instruction program based on the specific educational objectives set out. The instruction units included Virtual Reality (VR) after carrying out the practical exercise; the instruction units were done in a sequential manner. All the instruction units were performed as per the schedule, every Monday of every week, as follows:

1. Experimental group: instruction unit was done using Virtual Reality (VR).
2. Control group: instruction unit was done using the conventional way of teaching.

The instruction unit of both groups ended on Thursday, February 20, 2025.

Post Tests

Post tests in order to assess the competence in the selected forward roll, handstand, and cartwheel skills were done to the experimental and control groups on Monday, February 24, 2025. Every student was given three chances to perform and all performances were recorded on video as was done in the pre-test, then the videos were shown to the judges for marking.

Statistical Methods

Analysis of the data was done using the Statistical Package for Social Science (SPSS). The following statistical measures were used in the analysis:

1. Arithmetic mean

2. Standard deviation
3. Pearson correlation coefficient (r)
4. Percentage
5. t-test (paired & independent)

RESEARCH RESULTS

Presentation and Discussion of the Results of Learning Selected Artistic Gymnastics Skills in the Two Research Groups

Presentation and Discussion of Difference Between the Pre-test and Post-test Performance in Learning Selected Artistic Gymnastic Skills in Two Different Research Groups

After the completion of data collection, researchers applied statistical tests in which a paired sample t-test was used to compare differences in the mean score of the pre-test and post-test performances.

Table 4. Presents the Differences Between the pre- and post-test Results in Learning Selected Artistic Gymnastics Skills

Group	Pre-Test Mean	SD	Post-Test Mean	SD	Calculated t-value	Sig.
Control	5.5944	0.93217	5.5717	0.85136	0.083	0.934
Experimental	7.3111	0.81426	8.3472	0.54871	-5.087	0.000

Comparison of Differences Between Pre-Test and Post-Test Results in Learning Selected Artistic Gymnastics Skills within Two Different Research Groups

As it can be seen in Table 4, the significance value (Sig.) for the experimental group is 0.000, which is less than 0.05. It indicates that there are statistically significant differences between the pre- and post-test results in learning the selected artistic gymnastics skills, with the latter being more beneficial.

The reason behind the differences in the learners' performance in the pre- and post-tests is the instructional units with the exercises contained within them and the overall quantity of instructional units. Additionally, the instructional units developed by the researchers utilized VR for the experimental group, while the control group used traditional instructional approaches. All these factors together contributed to the improved learning process and increased proficiency of performing the selected artistic gymnastics skills. The learning process and skills acquisition were facilitated not only by the use of visualization of the skills with the help of modern technologies but also by the positive influence on the motivation of learners thanks to the variety of the instructional approaches and teaching materials used (Sahir Razzaq, 1993).

Demonstration of the Differences in the Post-Test Results of the Two Research Groups in Learning Selected Artistic Gymnastics Skills

Table 5. Contains the results of the independent-samples t-test for the post-test results of the control and experimental groups in learning selected artistic gymnastics skills.

No.	Variable	Group	Mean	SD	Mean Difference	SE Difference	t	Sig.	Significance
1	Virtual Reality	Control	5.571	0.851	-2.775	0.238	-	0.000	Significant
		Experimental	8.347	0.548			11.65		

Significant at $p < 0.05$.

The statistics shown in Table (5) indicate that there exist significant statistical differences between the experimental group which used the learning program based on virtual reality and the control group which used the learning program based on the ministerial curriculum.

DISCUSSION

Discussion about Post-Test Differences Between the Two Research Groups on Learning Selected Artistic Gymnastics Skills

In Table 5 the post-test results of the experimental and control groups have been presented, showing statistically significant differences in favor of the experimental group using Virtual Reality (VR). This finding supports the effectiveness of the instructional method used by the researchers, since the instructional units created for the experimental group included means that helped the learners combine previous experience with new one and use more efficient cognitive strategies for the process of learning.

It should be noted that according to the researchers, another favorable feature that contributed to the success of the experimental group was the creation of a constructive learning environment by the teacher through the use of diverse instructional exercises aimed at the development of targeted skills. Such an approach made the instructional units more stimulating, interesting and enjoyable, and therefore it encouraged active interaction, greater willingness, enthusiasm and motivation to perform the activities carefully. Qasim Lazam (2005) claimed that "Diversity in the use of exercises, methods and approaches during the process of teaching skills is the best way of creating a situation of stimulation, excitement and enjoyment for the learner, which will speed up the learning and acquisition of movements and sports skills."

Furthermore, the instructional units were created using a scientific methodological approach to the learners and their abilities, which encouraged greater willingness and enthusiasm to perform the activities and thus facilitated greatly the acquisition of technical skills. The use of VR allowed the learners to observe the process of technical performance from the first-person view and to find out the mistakes and correct the technical performance. Muneer (2017) stated that "Virtual reality technologies involve the fusion of reality and imagination and the creation of an environment that resembles reality, where objects and their motions can be represented and perceived through the creation of a multimedia environment filled with rich sensory information."

The advantage of the experimental group on technical skills is based on the fact that VR has helped learners form an adequate image of the necessary skills, learn necessary information, and find and correct mistakes in technical performance so as not to make them in the future and ensure correct technical performance. All this was due to the components of the VR program that engaged cognitive functions of learners and developed their visualization skills for technical performance. In addition, the program contributed to paying attention to the most important aspects of performance, so that learners could use their cognitive skills to determine the proper technical execution of the skill using their physical skills to achieve good technical performance.

All these factors were shown by students' technical performance that was significantly improved. The instructional program created a positive and motivating learning environment that engaged students' attention, increased their concentration, made them motivated to study and ready to complete necessary tasks and assignments, thus making them interested (Sawsan Saad, 2020).

Nagasubramani and Raja (2018) also pointed out the importance of modern technologies in the educational process because "integration of modern technologies in the learning process helped change teaching methods, as well as overcome difficulties of traditional education."

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

1. The instructional program conducted on the experimental group through Virtual Reality (VR) yielded positive results in terms of enhancing the development of certain floor exercises skills in artistic gymnastics for students enrolled at Al-Jihad Preparatory School for Boys under the Kirkuk Directorate of Education.

2. Clearly, the experimental group outshone the control group in the post-test.

Recommendations

1. The instructional programs designed by the researchers through Virtual Reality (VR) could be applied to facilitate learning process of selected floor exercises skills in artistic gymnastics for students enrolled at Al-Jihad Preparatory School for Boys under the Kirkuk Directorate of Education.
2. More attention should be paid to the application of Virtual Reality (VR) in teaching selected floor exercises skills in artistic gymnastics for such students. Further research could take into account more advanced technologies and cover larger samples of sports activities..

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