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Research Paper

The Effect of Using Interactive Augmented Reality Technology in Developing Visual Perception and Learning the Technical Steps of the Discus Throw Event

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ABSTRACT

This study aimed to investigate the effects of augmented reality technology on the development of visual perception among second-year students of the Faculty of Sports Sciences at the University of Kirkuk. The study examined the results of the visual perception scale when throwing the discus, learning the technical steps, and performing a technical step test (study in progress). The researchers chose the experimental method because it suited the type of research being conducted. They used an experimental design that conducted pre-tests and post-tests on both the experimental and control groups. The researchers randomly selected a sample of 50 second-year students at the Faculty of Sports Sciences at the University of Kirkuk. The main findings include: differences between the control and experimental groups in visual perception, with the experimental group performing better; differences between the control and experimental groups in discus throw performance and numerical range, with the experimental group performing better. The main recommendations include: the importance of using augmented reality technology in physical education and its integration into training programs; and improving visual representation in physical education classes.

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1. INTRODUCTION

We live in an era that is witnessing rapid advancements in educational technology, which sometimes exceed human imagination and comprehension, and are proceeding at a speed almost faster than our ability to keep up with them. One of the most prominent of these changes is the tremendous transformation in information technology. The world today is witnessing a massive digital technological revolution and an accelerating information explosion. The only way to keep pace with this development is through education and its curricula. There is no doubt that the digital revolution was born from the electronic world, which has brought about numerous technological, cultural, social, and other changes in various aspects of life. There is increasing recommendation regarding the importance of designing and developing interactive e-learning environments and employing them in a manner that is compatible with educational objectives, as well as leveraging the applications of modern communications technologies to improve the educational process. E-learning environments are characterized by a variety of educational media and enrichment topics, their ability to support interaction between students,

peers, and faculty, the ability to self-learn in an asynchronous manner, the ability to update educational content as needed at any time, and greater control over learning tools, which reflects the learner's level of achievement (Ismail, 2009: 210). Accordingly, the use of augmented reality applications has witnessed significant development in recent years, enabling users to interact with augmented reality to support educational materials using smart phones and tablets. Applications have become more accessible, and interaction with them has become more effective. Implementation challenges and low costs have become less complex and more widely used. Technology for augmented reality can also be employed throughout the learning process to assist students interact with and visually perceive information more easily and conveniently as opposed to virtual reality. It can also provide students with many approaches to information representation and testing dynamically, quickly, and easily. It also provides effective learning. (Catenazz, 2013: 12)
The researchers point out that augmented reality technology has continued to advance and develop until it was employed throughout the learning process to assist students interact with and comprehend information more easily and conveniently. In light of this, Yuen et al. (2011) observed that augmented reality allows for the display of three-dimensional images of objects in space, allowing learners to interact with these objects as if they were in front of them. They can move them in different directions and verify the validity of cosmic phenomena themselves (Yuen, 2011: 21).
Anderson, E., & Liarokapis (2010) believe that augmented reality technology has many advantages. It provides clear and accurate information, enables easy and effective information entry, and facilitates communication between a teacher and a student, for example and the learner. Furthermore, it provides powerful information despite its simplicity of use, making complex procedures easy for users, and is easily scalable and cost-effective. (Anderson, 2010: 2)
The results of numerous studies examining The efficiency of augmented reality use technology in teaching have shown that its use during the educational process helps learners be more creative, think more effectively, and increase achievement. Many studies have also recommended its use in education, after their results demonstrated the positive impact of its use in the educational process. The visualization strategy is an important element in the educational process, as it plays a significant role in enabling students to apply the knowledge and concepts they have observed in the classroom. Furthermore, it extends educational activities from school to real life. Visual perception is a special ability that involves understanding and perceiving spatial relationships, circulating mental images, and imagining the positions of shapes in the imagination. This ability manifests itself in every mental activity characterized by visual perception of the movement of flat and solid shapes, and in imagining the movement or spatial displacement of a shape or some of its parts (Moawad, 2008: 4). Therefore, the researchers believe that the use of interactive augmented reality technology is important in that it helps visual perception contribute significantly to the search for new things and activates the learner's role, in addition to its importance in improving the learning process. This generated the researchers' desire to engage in this research.

Research Problem:

Through their work as instructors specializing in athletics, the researchers observed that the approach used to teach the technical steps of the discus throw relied solely on one source: the teacher, who provided the explanation and modeling, without any active involvement of the students in the learning situation and without consideration for their abilities, levels, or individual differences. There was also a lack of interest in employing modern technologies in teaching physical education, despite their importance in the sports field. This prompted the researchers to consider conducting an experimental study that would encourage the use of augmented reality to improve visual perception and incorporate technological developments into teaching the technical steps of the discus throw.

Research Objectives:

1. To understand the visual perception development of second-year students of the Faculty of Physical Education and Sports Sciences at the University of Kirkuk through the evaluation of the Visual Perception Scale for Discus Throwing.
2. Second year students at the Faculty of Education and Sports Sciences at the University of Kirkuk will learn the technical steps to throw the discus effectively through a computer-based cognitive performance assessment and a test measuring the technical steps to throw the discus effectively (under investigation).

Research Hypotheses:

1. There is a statistically significant difference in the mean scores of the control group before and after the test on the visual perception and technical skills scale of discus throwing for the second-year students of the Faculty of Education and Sports Sciences of the University of Kirkuk, and the post-test scores are higher than those of the control group.
2. There was a statistically significant difference in the mean scores of the pre-test and post-test of the experimental group of the Visual Perception and Discus Throwing Technical Skills Scale for the second-year students of the Faculty of Education and Sports Sciences of the University of Kirkuk, and the post-test scores were better than those of the pre-test.
3. There were statistically significant differences between the two study groups (control group and experimental group) in terms of visual perception and technical skills of discus throwing among the second-year students of the Faculty of Education and Sports Sciences of the University of Kirkuk, with the experimental group being more favorable.

Field Research Procedures:

1. **Research Methodology:**

Since the experimental method suited the nature of this study, the researcher adopted this method. Two groups of subjects, experimental and control, were given a pre-test and a post-test as part of the experimental design.

2. Research Community and Sample

2.1 Research Community and Sample: The research team consisted of 160 second-year students of the Faculty of Physical Education and Sports Sciences at the University of Kirkuk in the academic year 2024/2025. The researchers randomly selected 50 second-year students of the Faculty of Physical Education and Sports Sciences at the University of Kirkuk and divided them into the following groups:

- Exploratory sample: composed of 26 students, used to calculate the scientific validity and reliability coefficients of the research variables.
- Primary sample: composed of 24 students, divided into:
- Experimental group: composed of 12 students, using augmented reality technology for experiments.
- Control group: composed of 12 students, using the experimental project prescribed by the school for experiments. As shown in Table 1.

Table 1: Research sample

Classification		Number of students	Percentage
Exploratory study sample		**26**	**52%**
Primary study sample	Experimental	**12**	**24%**
	Control	**12**	**24%**
Total sample number		**50**	**100%**

In order to control the variables that may affect the research methods, the basic characteristics of the sample (to be studied) were evaluated using variables such as age, weight and height. This is shown in Table (2) below.

Table 2. Statistical significance of pre-experimental baseline variables for the study sample N = 50

Variables	Units	Mean	Median	Std	Skewness	Flattening coefficient
Age	**Year**	19.86	19.50	2.36	0.58	-0.25
Weight	**Kg**	76.14	75.00	1.58	1.02	0.83
Height	**Cm**	175.39	176.00	1.94	1.13	1.09

Since the values of the skewness coefficient range from 0.58 to 1.13, which is close to zero, and the values of the flatness coefficient range from -0.25 to 1.09, Table 2 shows that the homogeneity of the research sample data in the basic initial measurements is moderate, non-discrete, and has the characteristics of a sample normal distribution. This shows that the fluctuations of the moderate curve are considered acceptable, and on average, there are neither upward nor downward fluctuations, confirming the similarity of the basic variables among the research team members before the experiment.

Measurements and Tests Used in the Study:

Visual Perception Scale:

The researchers developed the visual perception scale shown in Appendix (1) for the study sample as the primary data collection tool. Its objective was to measure the visual perception of the technical steps of discus throwing among the second year students of the Faculty of Physical Education and Sports Sciences at the University of Kirkuk. The researchers submitted the results of the scale to a panel of nine experts to seek their opinions on the following points:

Ensuring the suitability and sufficiency of the statements to the scale, ensuring the correctness of the wording and clarity of the statement, and adding, deleting, modifying, or combining statements.

Table 3: Frequencies and percentages of experts' opinions on each statement of the visual perception scale

Axis	S	Repetition	Percentage	Notes	Axis	S	Repetition	Percentage	Notes
The First	1	**9**	**100%**		**Third**	21	**9**	**100%**	
	2	**9**	**100%**			22	**9**	**100%**	
	3	**9**	**100%**			23	**9**	**100%**	
	4	**9**	**100%**			24	**9**	**100%**	
	5	**9**	**100%**			25	**9**	**100%**	
	6	**9**	**100%**			26	**7**	**77.78%**	
	7	**9**	**100%**			27	**9**	**100%**	
	8	**9**	**100%**			28	**9**	**100%**	
	9	**9**	**100%**			29	**9**	**100%**	
	10	**9**	**100%**			30	**8**	**88.89%**	
The second	11	**9**	**100%**		**Fourth**	31	**9**	**100%**	
	12	**8**	**88.89%**			32	**9**	**100%**	
	13	**9**	**100%**			33	**9**	**100%**	
	14	**9**	**100%**			34	**9**	**100%**	
	15	**9**	**100%**			35	**9**	**100%**	

	16	9	100%			36	9	100%	
	17	8	88.89%			37	9	100%	
	18	9	100%			38	7	77.78%	
	19	9	100%			39	9	100%	
	20	9	100%			40	9	100%	

Table (3) shows the frequencies and percentages of the experts' opinions regarding each statement in the visual perception scale, which ranged between (70.78% - 100%). The researcher accepted an agreement rate of (70%) or more, and therefore no modifications were made to the statements in the visual perception scale.

1. Internal consistency validity:

By determining the correlation coefficient between each statement's score and the scale's overall score, as indicated in Table (4), the validity of the statements in the visual perception scale was verified.

Table 4. Correlation coefficients between the score of each statement, the score of the axis to which it belongs, and the total score of the questionnaire

Axis	No.	Pearson's correlation coefficient		Axis	No.	Pearson's correlation coefficient	
		Phrase with axis	Phrase with questionnaire			Phrase with axis	Phrase with questionnaire
First	1	*0.625	*0.610	Third	21	*0.632	*0.877
	2	*0.717	*0.910		22	*0.505	*0.723
	3	*0.562	*0.459		23	*0.799	*0.666
	4	*0.512	*0.910		24	*0.659	*0.832
	5	*0.615	*0.563		25	*0.784	*0.832
	6	*0.699	*0718		26	*0.584	*0.666
	7	*0.388	*0.394		27	*0.694	*0.653
	8	*0.688	*0.741		28	*0.856	*0.514
	9	*0.682	*0.854		29	*0.790	*0.728
	10	*0.520	*0.910		30	*0.745	*0.636
Second	11	*0.585	*0.615	Fourth	31	*0620	*0.493
	12	*0.745	*0.841		32	*0.859	*0.625
	13	*0.529	*0.901		33	*0.451	*0.534
	14	*0.651	*0.748		34	*0.509	*0.653
	15	*0.801	*0.910		35	*0.580	*0.577
	16	*0.480	*0.700		36	*0.784	*0.596
	17	*0.621	*0.732		37	*0.801	*0.534
	18	*0.469	*0.818		38	*0.821	*0.733
	19	*0.741	*0.912		39	*0.402	*0.615
	20	*0.901	*0.918		40	*0.506	*0.748

*Statistically significant at 0.05 (Pearson's tabular correlation coefficient = 0.381)

Table (4) shows that the correlation coefficients between each statement and the axis of the total scale are statistically significant.

Reliability

As shown in Table 5, the reliability of the scale statement was assessed using the Cronbach alpha coefficient.

Table 5. Cronbach alpha reliability coefficients for the visual perception scale statements

Axis	No.	Reliability coefficient in case of deleting the phrase		Axis	No.	Reliability coefficient in case of deleting the phrase	
		Axis	For survey			Axis	For survey
First	1	0.870	0.939	Third	21	0.870	0.939
	2	0.873	0.939		22	0.887	0.939
	3	0.897	0.939		23	0.865	0.939
	4	0.898	0.939		24	0.870	0.939
	5	0.861	0.939		25	0.871	0.939
	6	0.869	0.939		26	0.869	0.939
	7	0.869	0.939		27	0.877	0.939
	8	0.872	0.939		28	0.884	0.939
	9	0.870	0.939		29	0.871	0.939
	10	0.856	0.939		30	0.865	0.939
Second	11	0.864	0.939	Fourth	31	0.859	0.939
	12	0.869	0.939		32	0.874	0.939
	13	0.888	0.939		33	0.871	0.939
	14	0.871	0.939		34	0.864	0.939
	15	0.871	0.939		35	0.873	0.939
	16	0.872	0.939		36	0.874	0.939
	17	0.864	0.939		37	0.875	0.939
	18	0.873	0.939		38	0.893	0.939

	19	0.864	0.939		39	0.874	0.939
	20	0.870	0.939		40	0.897	0.939

Cronbach's alpha coefficient ≥ 0.70.

Table (5) shows that the reliability coefficient of the scale statements is acceptable (greater than 0.70), indicating that the scale statements are stable, and omitting a statement will have a negative impact on the reliability of the scale.

2. Measuring the skill performance level for the stages of the discus throw event under study:

The researchers measured the skill performance level using a committee of experts consisting of three physical education professors. A skill performance evaluation form for the stages of the discus throw event was used. The form included the skill stages (carrying the discus, ready position, preliminary swings, rotations, transition phase, throwing phase, follow-through, and balance). Each element was assigned (10) points in the evaluation form, according to the experts' opinions. The researchers then calculated the arithmetic mean of the experts' scores for each stage of the skill performance level for the stages of the discus throw event under study.

3. Measuring the Level of Digital Achievement in Discus Throwing Under Study

The level of digital achievement in the discus throw event is calculated from the end of the throwing circle to the nearest part of the discus in the landing zone.

Preparing and Implementing Educational Units Using Augmented Reality (for the Experimental Group)

After reviewing scientific references in the field of preparing and designing educational units using modern technologies and augmented reality, the researchers prepared the educational units (under study) using augmented reality using a program following the ADDIE MODEL. This model derives its name from its constituent steps, which consist of five main steps: (Analysis - Design - Development - Production - Implementation - Evaluation).

General Timeframe for Implementing the Educational Units (under Study):

The timeframe for implementing the research plan for the experimental group was set for four educational units, with one lesson per week for each unit, lasting (90) minutes. The following table illustrates this:

Table 6. General Timeframe for Implementing the Educational Units for the Experimental Research Group

Number of educational units	**6 educational units**
Number of weeks	6 weeks
Number of lessons	6 lessons
Number of lessons per week	1 lesson
Lesson implementation time	(90) minutes
Total time for learning units	540 minutes (9) hours

Table 7: Content of educational units using (augmented reality) for the experimental group

S	**Educational unit**	**The lesson**	**Lesson content**
1	Disc Carry	First	Discus holding instruction
2	Ready Position	First	Ready position instruction
3	Preliminary Swings	Second	Preliminary swing instruction
4	Spins	Third	Rotation instruction
5	Transition Phase	Fourth	Transition instruction
6	Throwing Phase	Fifth	Throwing instruction
7	Follow-Through and Balance	Sixth	Follow-up and balance instruction
Total	(6) Instructional Units	(6) Lessons	

The Primary Study:

The primary study was conducted from February 11, 2025 to March 30, 2025, and was conducted as follows:

1. Pre-measurement

The preliminary measurement of the study variables was conducted between February 1 and 10, 2025. The study sample included 24 students, divided into 12 experimental groups and 12 non-experimental groups. The pretest was conducted at the Faculty of Physical Education and Sports Sciences, University of Kirkuk.

Equivalence between two groups (control group - experimental group):

Table 8: Equivalence of the control group and the experimental group on the main variables before the experiment
N1 = N2 = 12

Variables	**control group**		**experimental group**		**T value**	**Significance level**
	Mean	**Std**	**Mean**	**Std**		
Age	19.37	1.59	19.49	1.23	0.51	0.67
Weight	76.12	2.19	75.86	1.78	1.32	0.21
Height	176.91	1.54	177.15	1.62	0.98	0.44

* Significant at the 0.05 level = 2.074

Table 9: Equivalence between the control and experimental groups on the axes of the visual perception scale before the experiment (N1 = N2 = 12)

Visual perception scale axes	Units	control group		experimental group		T value
		Mean	Std	Mean	Std	
Axis 1: Visual perception of stance and preparation	Degree	14.54	1.20	15.01	1.02	1.05
Axis 2: Visual perception of rotation and transition	Degree	17.95	1.36	17.52	1.11	0.86
Axis 3: Visual perception of the release phase	Degree	13.82	0.82	13.49	1.05	0.99
Axis 4: Visual perception of the final follow-through	Degree	15.17	0.47	15.51	0.86	066
Total score on the visual perception scale	Degree	61.48	1.69	61.53	1.86	0.25

The t-value at a significance level of (0.05) = 2.074.

Table 10: Are the performance levels of the control group and the experimental group in the discus throwing phase consistent with the numerical levels before the experiment

Variables	Units	control group		experimental group		T value
		Mean	Std	Mean	Std	
Discus Carrying	Degree	2.64	1.02	2.55	0.89	0.86
Ready Position	Degree	3.01	0.86	2.99	0.94	0.47
Preliminary Swings	Degree	1.97	0.74	2.02	0.64	0.36
Spins	Degree	1.27	0.44	1.21	0.53	0.78
Transition Phase	Degree	2.39	0.28	2.31	0.34	0.35
Throwing Phase	Degree	3.02	0.81	2.86	0.79	1.01
Follow-Through and Balance	Degree	3.14	0.76	3.01	0.89	0.73
Disc Throwing Digital Level	Meter	22.14	1.36	22.89	1.58	0.84

At the significance level of 0.05, the t value is 2.074. There is no significant difference between the experimental group and the control group in the discus throwing performance level and numerical level before the experiment at the 0.05 level, as shown in the statistical significance values of these variables in Table (10). The calculated t values range from 0.35 to 1.01. These values are less than the tabular values of t at the significance level of 0.05 = 2.074 and above 0.05, proving the equivalence of the two groups in the discus throwing performance level and numerical level before the experiment.

Program Implementation

The proposed program is for the experimental group (12 students). The program developed by the school is for the control group (12 students). The proposed educational program will be implemented for six weeks, from February 15, 2025 to March 31, 2025, with the main sample (experimental group) having one class per week.

Post-Measurement:

Post-measurements of the variables under study were conducted on the research sample members from April 1, 2025, to April 10, 2025, at the College of Physical Education and Sports Sciences at the University of Kirkuk.

Statistical Processes Used in the Research:

Statistical equations (arithmetic mean, standard deviation, median, skewness coefficient, kurtosis coefficient, t-test, Pearson correlation coefficient, frequency, and percentage) were employed in the statistical program (SPSS).

RESULTS AND DISCUSSIONS

Presentation and Discussion of Results

First: Introduction and Discussion The results of the first hypothesis. The mean scores of the control group on the visual perception and technical skills scale of discus throwing for the second-year students of the Faculty of Education and Sports Sciences of the University of Kirkuk on the pre-test and post-test were statistically significantly higher than those on the post-test.

Table 11. Statistical significance of t-test differences in the visual perception scale before and after the control group (n = 12)

Visual perception scale axes	Units	control group				T value
		Pretest		Posttest		
		Mean	Std	Mean	Std	
Axis 1: Visual perception of stance and preparation	Degree	14.54	1.20	17.63	1.75	4.39
Axis 2: Visual perception of rotation and transition	Degree	17.95	1.36	20.74	1.33	4.87
Axis 3: Visual perception of the release phase	Degree	13.82	0.82	18.45	1.92	5.39
Axis 4: Visual perception of the final follow-through	Degree	15.17	0.47	19.31	0.95	5.87
Total score on the visual perception scale	Degree	61.48	1.69	76.13	1.84	6.01

At the significance level (0.05), the t value = 2.201. The results in Table (11) show that there is a statistically significant difference between the mean values of the pre-test and post-test of the control group at the (0.05) level, while the post-test mean values of each axis of the visual perception scale are better because the calculated t values are between (4.39:6.01).

Table 12. Statistical significance of t-test differences between the performance level of discus throwing skill level and the numerical level of the control group at pre-test and post-test measurements (n = 12)

Technical stages	Units	control group				T value
		Pretest		Posttest		
		Mean	Std	Mean	Std	
Discus Carrying	Degree	2.64	1.02	4.15	0.86	3.48
Ready Position	Degree	3.01	0.86	5.01	1.13	3.79
Preliminary Swings	Degree	1.97	0.74	3.15	1.08	2.78
Spins	Degree	1.27	0.44	4.91	0.64	3.19
Transition Phase	Degree	2.39	0.28	5.13	0.83	4.18
Throwing Phase	Degree	3.02	0.81	6.12	0.99	4.89
Follow-Through and Balance	Degree	3.14	0.76	5.84	1.15	3.94
Disc Throwing Digital Level	Meter	22.14	1.36	24.87	1.97	4.01

The t-test value at a significance level of (0.05) = 2.201.

The results in Table (12) show:

- There was a statistically significant difference (0.05) between the pre- and post-test mean scores of the control group in terms of performance and numerical levels of the discus throwing skill phases (holding the disc, preparation position, transition phase, throwing phase, follow-up movement, and balance) in favor of the post-test mean as the calculated t-test values were between (3.48:4.89).
- The pre- and post-test means of the control group were not statistically significantly different at the (0.05) level, whereas the post-test means of the discus throwing skill level (preliminary weight, rotation) were more in favor of the performance level as the calculated t-test values were between (2.78:3.19).

Second: Hypothesis Results and Discussion Secondly, the experimental research group found statistically significant differences between the pre- and post-measurement means of the visual perception and discus throwing technical skills scales of the second-year students of the Faculty of Education and Sports Sciences of the University of Kirkuk, which is conducive to the post-measurement.

Table 13. Statistical significance of t-test differences in pre- and post-tests of the Visual Perception Scale and percentage improvement in the experimental group (n = 12)

Visual perception scale axes	Units	experimental group				T value
		Pretest		Posttest		
		Mean	Std	Mean	Std	
Axis 1: Visual perception of stance and preparation	Degree	15.01	1.02	22.78	1.74	8.04
Axis 2: Visual perception of rotation and transition	Degree	17.52	1.11	26.70	0.93	13.84
Axis 3: Visual perception of the release phase	Degree	13.49	1.05	24.79	1.36	15.93
Axis 4: Visual perception of the final follow-through	Degree	15.51	0.86	26.01	1.45	12.41
Total score on the visual perception scale	Degree	61.53	1.86	100.28	2.01	19.78

The t-value at a significance level of (0.05) = 2.201.

The results in Table 13 show that there is a statistically significant difference between the pre-test and post-test means of the experimental group at the 0.05 level, and the post-test mean is more significant on the visual perception scale axis. The calculated t value is between (8.04:19.78).

This is what Mustafa Al-Sayeh (2004) indicated: If information is presented to the learner through more than one medium that addresses more than one of the learner's different senses, it is more effective and better than if it is presented through a single medium. (Al-Sayeh, 2004: 15)

This is confirmed by Samia Al-Harjasi (2004) who stated that the use of visual and audio media (video) helps improve, master, and consolidate motor skills by using visual-auditory connections, which stimulates individual abilities and ensures progress and development. (Al-Harjasi, 2004: 160)

Christie (2004) indicates: Rodgers (2014) points out that the use of augmented reality technology supported by 3D displays contributes to achieving educational goals, motivates students, and contributes to the development of visual perception skills (Christie, 2014: 57).

Table 14. Statistical significance of the t-test differences between the pre- and post-test measurements in the skill performance level of the discus throwing skill stages, the numerical level, and the percentage of improvement for the experimental group (n = 12)

Technical stages	Units	experimental group				T value
		Pretest		Posttest		
		Mean	Std	Mean	Std	
Discus Carrying	Degree	2.55	0.89	7.18	1.08	6.84
Ready Position	Degree	2.99	0.94	8.15	0.56	7.89
Preliminary Swings	Degree	2.02	0.64	7.94	0.78	6.47
Spins	Degree	1.21	0.53	7.67	1.62	8.91
Transition Phase	Degree	2.31	0.34	7.91	1.14	9.17
Throwing Phase	Degree	2.86	0.79	8.19	0.78	7.48
Follow-Through and Balance	Degree	3.01	0.89	9.02	0.39	10.30
Disc Throwing Digital Level	Meter	22.89	1.58	28.41	1.02	8.18

The t-test value at a significance level of (0.05) = 2.201.

Table 14 shows that there is a significant difference between the mean scores of the pre-test and post-test of the experimental group at the 0.05 level, and the mean of the post-test is better in terms of the skill level of discus throwing and digital throwing. The calculated t-test value is between (6.47:10.30). This was confirmed by Iman Muhammad Al-Gharab (2003), who stated that Internet-based learning has multiple advantages, leading to e-learning, which delivers educational material to students wherever they are, in a manner that suits their needs and abilities. This is especially true after the Internet has reached most parts of the world, and its distinctive feature of providing content rich in interactive multimedia, by establishing multi-party digital relationships between the teacher, the educational material, and the students themselves, with its low cost. (Al-Gharab, 2003: 41)

Third: Results and discussion of the third hypothesis: There are statistically significant differences between the two study groups (control group and experimental group) in visual perception and discus throwing technical skills of the second-year students of the Faculty of Education and Sports Sciences of the University of Kirkuk, with the experimental group being superior.

Table 15. Statistical significance of the t-test differences in the post-test of the visual perception scale between the control and experimental groups (n1 = n2 = 12)

Visual perception scale axes	Units	control group		experimental group		T value
		Mean	Std	Mean	Std	
Axis 1: Visual perception of stance and preparation	Degree	17.63	1.75	22.78	1.74	5.12
Axis 2: Visual perception of rotation and transition	Degree	20.74	1.33	26.70	0.93	9.75
Axis 3: Visual perception of the release phase	Degree	18.45	1.92	24.79	1.36	8.41
Axis 4: Visual perception of the final follow-through	Degree	19.31	0.95	26.01	1.45	7.69
Total score on the visual perception scale	Degree	76.13	1.84	100.28	2.01	14.36

The t-test value at a significance level of (0.05) = 2.074.

The results of Table (15) reveal the following:

- On the visual perception scale, there was a statistically significant difference in the mean post-test scores between the experimental and control groups at the 0.05 level, with the experimental group performing better. The calculated t-test value was (5.12: 14.36).

Anderson and Liarokapis (2010) believe that augmented reality technology has many advantages. It provides clear and accurate information, enables easy and effective information entry, and facilitates communication between a teacher and a student, for example and the learner. Furthermore, it provides powerful information despite its simplicity of use, making complex procedures easy for users, and is easily scalable and cost-effective. (Anderson, 2010: 2). Khaled Noufal (2010) pointed out that augmented reality technology is considered to be one of the most important concepts in modern information technology. It refers to the fusion of the real environment with the virtual reality in the real environment. (Noufal, 2010: 44)

Table 16. Statistical significance of t-test differences between the control group and the experimental group in terms of post-test performance level and numerical level of discus throwing skill level (n1 = n2 = 12)

Technical stages	Units	control group		experimental group		T value
		Mean	Std	Mean	Std	
Discus Carrying	Degree	4.15	0.86	7.18	1.08	4.94
Ready Position	Degree	5.01	1.13	8.15	0.56	3.91
Preliminary Swings	Degree	3.15	1.08	7.94	0.78	4.28
Spins	Degree	4.91	0.64	7.67	1.62	4.01
Transition Phase	Degree	5.13	0.83	7.91	1.14	3.76
Throwing Phase	Degree	6.12	0.99	8.19	0.78	4.12
Follow-Through and Balance	Degree	5.84	1.15	9.02	0.39	5.01
Disc Throwing Digital Level	Meter	24.87	1.97	28.41	1.02	4.52

The t-test value at a significance level of 0.05 = 2.074.

The results of Table (16) reveal the following:

- There were statistically significant differences at the 0.05 level between the average scores of the post-test for the experimental group and the control group in terms of skill performance levels for the discus throwing skill stages and the numerical level, in favor of the experimental group. The calculated t-test value ranged between (3.76: 5.01).

Catenazz & Sommaruga (2013) believe that Technology for augmented reality can be employed throughout the learning process to assist students interact with and visually perceive information more easily and conveniently as opposed to virtual reality. It can also provide learners with many approaches to information representation and testing dynamically, quickly, and easily. It also provides effective learning. (Catenazz, 2013: 12)

In this regard, Enayat Farag and Faten Al-Batal (2004) point out that modern technologies play a key role in motor learning and help raise the level of performance. They stimulate the learner, satisfy their learning needs, and provide a variety of experiences (Farag and Al-Batal, 2004: 63). Through the above, the researcher believes that the use of interactive augmented reality technology during educational units played a role in developing visual perception, in addition to learning the art of performance, technical steps, and digital achievement in the weight-throwing activity, as augmented Reality technology provides learners with great flexibility, allowing them to try and explore the learning environment. Augmented reality technology can also develop real-world learning content (such as books, presentations and learning tools) in different ways. Various graphic elements (including two-dimensional and three-dimensional images) are added, and the display of video clips, pictures, and static and dynamic images is also increased to meet the individual needs of learners. This helps to cultivate thinking skills and promote the development of experimental groups. The members of the experimental group who learned using augmented reality improved their perception and interacted better with the educational material. Thus, they developed visual perception and thus became able to mentally process the visual objects included in the program. This was confirmed by both Ihsan and Mohammed in order to develop thinking, as learners need to be equipped with thinking skills in order to effectively compete in an era where success, excellence, and control are determined by the extent of a person’s ability to think well and skillfully. (Ihsan and Mohammed, 2023, 127).

CONCLUSIONS

1. The control group achieved a significant increase in the axes of the visual perception scale for students of the College of Physical Education and Sports Sciences in discus throwing. It also achieved a significant increase in the technical steps of the discus throw (carrying the discus, ready position, transition phase, throwing phase, follow-through, and balance) and the digital level of the discus throw. It did not achieve a significant increase in the technical steps of the discus throw (preliminary swings, rotations).
2. The experimental group achieved a significant increase in the axes of the visual perception scale for students of the College of Physical Education and Sports Sciences in discus throwing. It also achieved a significant increase in the level of skill performance for the discus throwing skill stages and the digital level.

There were significant distinctions between the control group and the experimental group group in the skill performance levels of the discus throw skill and in the numerical level in favor of the experimental group.

1. The use of augmented reality technologies with the experimental group affected the development of visual perception and learning of the technical steps for the discus throw for students in the College of Physical Education and Sports Sciences.

Recommendations

1. The importance of using augmented reality technology in the classroom motor skills. Encourage teachers and trainers to use augmented reality and include visually enhanced educational and training programs within the sports curricula.
2. Design specialized augmented reality applications for teaching sports skills.
3. Provide a technical infrastructure that supports the use of augmented reality in educational institutions.

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