The Effectiveness of Using Augmented Reality Technology in Developing Academic Achievement in Earth Sciences and Environment Subject for 9th Grade Student.

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Abstract

This study aimed to measure the effectiveness of the use of augmented reality technology in developing academic achievement in earth and environmental sciences subject for ninth grade students. The study sample consisted of (50) 9th grade students at the Creative Nations School in Amman, Jordan during the second semester of 2019/2020. The sample was distributed in two groups; an experimental group of (25) students taught using the augmented reality (AR) teaching method, and a control group of (25) taught using the traditional method. The results indicated statistically significant differences at the level ($\alpha = 0.05$) between the mean grades of students of the two experimental and control groups, on the post achievement test, for the performance of the ninth-grade students in the pre and post-tests in earth and environmental sciences subject, and for all sub-levels, in favor of the experimental group. In the light of the results of the study, the researchers recommended using AR technology for students at all age levels.

فاعلية استخدام تكنولوجيا الواقع المعزز في تطوير التحصيل الأكاديمي في مادة علوم الأرض والبيئة لطلبة الصف التاسع

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الملخص

هدفت هذه الدراسة إلى قياس مدى فاعلية استخدام تقنية الواقع المعزز في تطوير التحصيل الأكاديمي في مادة علوم الأرض والبيئة لطلبة الصف التاسع. تكونت عينة الدراسة من (50) طالب وطالبة من طلبة الصف التاسع في مدرسة إبداع الأمم في عمان – الأردن، خلال الفصل الدراسي الثاني 2019/2020، موزعين على مجموعتين، حيث تم تدريس مجموعة تجريبية قوامها (25) طالباً وطالبة باستخدام طريقة تدريس الواقع المعزز(AR) ، بينما تم تدريس المجموعة الضابطة المكونة من (25) طالباً وطالبة بالطريقة الاعتيادية. أشارت النتائج إلى وجود فروق ذات دلالة إحصائية على مستوى ($\alpha = 0.05$) بين متوسطي درجات طلبة المجموعتين التجريبية والضابطة، في اختبار التحصيل البعدي، لأداء طلبة الصف التاسع في الاختبار القبلي والبعدي في مادة علوم الأرض والبيئة، ولجميع المستويات الفرعية لصالح المجموعة التجريبية. وفي ضوء نتائج الدراسة، أوصى الباحثان باستخدام تقنية الواقع المعزز للطلبة في جميع المراحل العمرية.

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Introduction

The current era is witnessing a development based on technology and its tools in all areas of life, and technological progresses have led to the emergence of new and diverse methods of the educational process based on the use of technological innovations, that has made a qualitative shift in achieving the educational objectives required for the learner.

The learner has achieved many learning opportunities according to his pace, learning style, taking into account the individual differences, as it varied by providing information in its various forms to the learner, both individually or collectively. This technique has also provided timely support and assistance in a way that suits the learner to achieve better learning.

The wireless, industrial revolution and modern technological development have shown a new reality with the ability to communicate online, that is the augmented reality (AR) that began to officially emerge at the beginning of the year (1990) when some companies like Boeing at the time used this technology to represent their data and train their employees through digital screens that direct workers while working to collect electrical wiring (Sid, 2011).

AR plays an important role in the teaching of scientific subjects, manifested by the benefits that can be observed through its use in the teaching of scientific subjects, through which a 3D image of things can be presented and simulated reality, it is also used to correct some misconceptions in students, as well as used in the process of training to solve different issues. This helps to reach the level of proficiency in teaching subjects, which helps to raise and develop positive trends among students towards subjects (Al-Dahasi, 2017).

It was used at the American University of Wisconsin in instructional games to increase students' interaction with educational materials, where ARIS program was used to create a virtual gaming environment that could be used in education. In addition, the German company Metayo has developed improved virtual games with elements of augmented reality, so that when the camera is directed at them, they interact with the real environment (Kipper, Rampolla, 2013; Yuen, Yaoyuneyong & Johnson, 2011).

The term AR suggests that virtual information can be integrated with the real world. When the learner uses this technique to look at the surrounding environment around him, the objects in this environment are provided with the information surrounding it, integrate and interact with the image that the learner looks at by directing the camera towards the image, then showing learner information, illustrations or interactive 3D videos, which add to the learner's excitement during education (Qansouh, 2018).

Among the characteristics of AR in education, it provides clear and accurate information, blends the real and virtual world in a real environment, facilitates complex actions of learners, allows collaboration and participation between students, provides instant interaction between real and virtual materials, as well as, it is easy to use and provide powerful information (Rizk, 2017).

One of the advantages of using AR in education and within the classroom environment is that it allows interaction between the teacher and the learner, is characterized by his ability to expand, and makes the procedures between the teacher and the learner clear, enabling the teacher to enter and communicate his information and data in an easy way, helping to provide him with clear and concise information (Zahrani, 2018).

For AR to be possible five basic tasks must be accomplished and their products integrated effectively (Chen, 2013):

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1. Image fragmentation: The process of separating the front direction of objects from their background, and the quality of the separation process determines the success of the process of extracting objects from the image.
2. Extraction: Means finding known elements on the image of lines, curves and shapes.
3. Mark detection: The real tag must be designed in a way that is easy to detect, identify and recognize among other markers.
4. Camera direction: This step comes after the mark is selected, where the mark is located in spatial space so that digital objects are embodied in the image, and their scope and direction must fit with the detected mark.
5. Embedding: At this stage, 3D objects are embodied within the scene and placed on the mark, taking into account the quality of embodiment and lighting (Epskamp, 2012).

Many societies attach great importance to educational achievement as it is a measure of an individual's intelligence and mental abilities. Therefore, those who are involved in educational programs are interested in academic achievement because the decisions that result in it provide educators with indicators of the goals of educational sciences, which in turn reflect society's aspirations for development and progress.

The academic achievement is considered one of the most important aspects of the learner's mental activity as it is the aspect that shows the learner's academic excellence, and the teacher uses the academic achievement to estimate the extent of achieving educational goals, and the results of the educational process achieved by the learner. Academic achievement is a complex process involving a number of factors and variables (Jalali, 2016).

Educational achievement is defined as: the level of achievement and competence in the school, measured by tests decided by the teacher or measured by the teacher by observation, and the total grades obtained by the student at the end of the semester are adopted as a measure of the level of academic achievement. (Al-Hamwi, Al-Ahmad, 2010).

Al-Dahashi (2017) conducted a study to detect the use of augmented reality technology in the development of mathematical thinking skills, necessary for a master's degree in curriculum and teaching methods. The study used the descriptive analytical approach. The sample of the study consisted of (120) primary school teachers and mathematicians. The study tools consisted of using a questionnaire to gather the necessary information as the most appropriate in achieving the objectives of the survey. The results of the study confirmed that augmented reality technology helps to identify the subject of the lesson, and that it helps increase students' cognitive abilities.

Abdul Hadi's study (2018) aimed to reveal the effectiveness of the use of augmented reality technology in the development of cognitive achievement and guidance among students of the Faculty of Education, using a semi-experimental curriculum based on the design of an experimental group and a controlled group with the prior and remote application of measurement tools. The experimental group consisted of 35 students studying augmented reality technology, and the control group consisted of (40) students studying using the traditional method. The results of the study indicated that there were no statistically significant differences at the level (0.05) between the average grades of experimental group students using augmented reality technology in the two measurement scales, and the post test on cognitive achievement and the attitude scale.

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Ghalib, & Norden, (2018) conducted a study aimed to learn how to use augmented reality technology in learning Arabic, Arabic language topics and skills that students can learn using technology. To achieve its objectives the study used the descriptive approach by reviewing scientific documents and documents printed at the university, as well as the development curriculum, where the researchers designed the unit according to the global design model. The most imported findings were the role of augmented reality technology and the importance of using it in learning Arabic, extracting a list of appropriate subjects and language skills for augmented reality learning, and building an Arabic-language module containing augmented reality elements within their educational activities.

Al-Ghamdi's study (2018) aimed to detect the impact of augmented reality use on math achievement among middle-school students, and the sample consisted of (60) middle- grade students in schools in Al-Sharawa Governorate, Saudi Arabia, who studied the atoms and elements unit in the science course for the first semester of the 2018/19 academic year. divided into two groups: the experimental group consisted of (30) students who studied reality technology, and the control group consisted of (30) female students, who studied in the traditional way. The results of the study revealed that there is no statistically significant effect between the fixed virtual object and the moving virtual object in relation to the survival of the learning effect and the motivation of achievement with regard to the cognitive style, while the results revealed the presence of a statistically significant effect in favor of the cognitive method of comparison compared to the cognitive style impulse in relation to the survival of the learning effect and motivation of achievement Without looking at the hypothetical (fixed / moving) object. The study results also indicated a statistically significant effect of the interaction between the moving virtual object and the cognitive style in relation to the survival of the learning effect, just as the study results indicated the presence of the effect of D Statistically, the interaction between the fixed virtual object and the cognitive style in relation to the achievement motivation.

Mahmoud, Amira, and Al-Muzain (2020) conducted a study aimed at providing commercial science teachers with the benefits of using augmented reality through a cloud training environment. The researchers used the developmental approach, as they relied on a design with one experimental group providing training content in several sessions, and the study procedures were applied to (27) teachers of commercial sciences at Kafr El-Sheikh Commercial Secondary School for girls and the hotel school in Kafr El-Sheikh, who have smart devices.

The study tools and materials were in a cloud training environment, a list of augmented reality capabilities, an augmented reality knowledge test, a note card for augmented reality use skills, and a development measure towards augmented reality use. The results of the study emphasized the effectiveness of the cloud training environment of business science teachers, which gave them the benefits of using augmented reality. The study recommended that the results of the current study be applied to other educational subjects and stages.

The current study is distinguished from previous studies in that it is one of the first studies - according to the limits of the researchers' knowledge - which dealt with the effectiveness of using augmented reality technology in the development of academic achievement in the subject of earth and environmental sciences for ninth graders. A survey of previous studies found that most of these studies did not link augmented reality in students' achievement in earth sciences. This gave justification for such a study.

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The Study Problem

The Arab world has recently witnessed a comprehensive and continuous development in its quest to improve learning outcomes, raise the level of quality and pay attention to students' thinking and development, but these outputs have not reached the required and acceptable level, where they include many problems such as low levels of achievement, poor concentration, and common teaching methods. The diversity of teaching methods and modern educational trends can contribute to challenging educational problems by developing students' thinking and learning abilities, and teaching them using modern techniques because of their positive impact on raising student achievement.

The problem with the study stems from the lack of use of augmented reality technology in science learning, the scarcity of scientific studies aimed at using augmented reality in learning, and the measurement of the extent to which students interact with it, despite the recent use of augmented reality techniques (as researchers know) to determine the impact of a training program to use augmented reality techniques in design and production using augmented reality technology (Epskamp, 2012). Thus, this study reveals the effectiveness of the use of augmented reality technology in the development of educational achievement in earth and environmental sciences among ninth graders. In the light of the above, the study tries to answer the following main question: **What is the effectiveness of using augmented reality technology in developing academic achievement in the subject of earth and environmental sciences for the ninth-grade students?**

Significance of Study

Theoretical importance:

a. The importance of this study came from the scarcity of studies and research -according to the researchers' knowledge- which dealt with the effectiveness of using augmented reality in education and developing academic achievement in the subject of earth and environmental sciences.

b. It also addressed the issue of the effectiveness of the use of augmented reality in education, which contributes to access to many plans and strategies to ensure the success of students in various subjects in general and in the earth sciences environment in particular.

c. The other important aspect of the study is that it deals with earth and environmental sciences for ninth graders, which is an important and influential subject for students in this age group.

Practical importance

The results of the study will provide researchers, educators and those interested in experimental studies with important information to benefit from their findings in some subsequent studies and research that could address the same subject at other educational stages. The results may also contribute to recommendations on how the use of augmented reality helps develop academic achievement in the subject of earth and environmental sciences.

Definitions of Terms

Augmented Reality (AR): It is a technology that aims to connect the virtual world to the real world through a purpose-prepared application compatible with tablets and smartphones to show cognitive content supported by 3D images, videos and other forms, graphics and illustrations and attract attention, making students more interactive with the material and linking it to life situations (Al-Dahasi, 2017). And procedurally defined: as a set of pictures, drawings and videos from the water unit in the book of Earth and Environmental Sciences that have been

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computerized and programmed to suit the application of augmented reality to the purpose-prepared application that students can learn to use it.

Achievement: It is defined as the academic level that the learner receives in the achievement test to study one or more academic subjects, represents the information and knowledge gained by the learner in this subject, and is determined by a test or learning test. (Haddah, 2013). Procedurally defined as: as the degree of achievement obtained by the students of the ninth grade in the achievement test after studying the subject of earth and environmental sciences and acquiring information and knowledge, and achieving the objectives of the unit set by the teacher of the subject of earth and environmental sciences.

Limitations and delimitations of the study

1. Objective limit: This study was limited to the water unit in the Book of Earth and Environmental Sciences.
2. Spatial limit: The study was limited to the School of Creative Nations in the Abu Naseer area of Amman, Jordan.
3. Time limit: The study time is determined in the second semester during the academic year 2019/2020.
4. Human limit: The study sample was restricted to ninth-grade students.
5. The generalization of the results of this study is determined by the degree of sincerity, stability and responses of the study members.

Methodology

Approach: This current study used the semi-experimental approach.

Study Sample:

The sample of the study was randomly selected that consisted of (50) students from the study community. The students were divided into two groups: the control group consisted of (25) students, and the experimental group that consisted of (25) ninth-grade students at the Creative Nations School in Abu Naseer district of Amman, Jordan, during the second semester of 2019/20.

Study Tools

Augmented Reality Technology: Researchers prepared augmented reality technology according to Dick and Carey's instructional model because it relies on the systematic approach to the instructional design model developed in 1996 by Walter Dick and Lou Carey. The model focuses on the need to view e-learning as an integrated process through formal processes, so that each element of the process is seen as important for accessing effective e-learning.

Achievement Tests: Achievement tests generally aim to measure what has been learned or achieved from the study's objectives and outcomes, and given the nature of the current study the cognitive aspect must be measured.

Validity of the achievement test: To verify the validity of the test, it was presented in its initial form of (35) items to a number of experienced referees and specialists in the subject of science, to ensure that the test questions measure the objective for which they were developed, and to ensure the integrity of the language, and the appropriate suitability of the level. In light of the opinions of the referees, the necessary modifications were made to (10) items of the test in terms of language, and 5 items were deleted, making the final form of the test consisting of (30) items. To find the score of each question and the total score, the Pearson correlation coefficient test was used. A statistically significant score was found at the level of ($\alpha=0.05$)

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between the score of each question and the total score of the test indicating the consistency of the test levels and their suitability for application.

Reliability of the Achievement Test: To verify the reliability of the test, the test was applied to a sample of (20) ninth graders from outside the study sample and then reapplied two weeks later. Pearson's correlation coefficient between the two applications was calculated. It was found to be equal to (0.943) and that was an acceptable result for the purposes of the study.

Paragraphs Analysis: The purpose of analyzing test elements is to improve testing by detecting weak items and working to reformulate, delete or exclude invalid items.

a. Difficulty coefficient and discrimination test items:The students' grades were arranged in ascending order in the questionnaire sample, and then the difficulty factor for each item was calculated, so it became clear that the difficulty factor ranges between (0.20 - 80.0), and the discrimination factors ranged between (0.8 - 0.35). These ratios are good and acceptable for the purposes of the study.

Findings

In relation to the study question: What is the effectiveness of using augmented reality technology in developing academic achievement in the subject of earth and environmental sciences for the ninth-grade students?, means, standard deviations, and adjusted mean were calculated for the achievement of the ninth-grade students in the subject of Earth and Environmental Sciences according to the group variable (control, experimental), and Table (1) illustrates this.

Table (1). Arithmetic Means, Standard Deviations, and Adjusted Arithmetic Means for the achievement of the ninth-grade students in Earth and Environmental Sciences subject to the group variable

Group	NO	Pre-Test		Post-Test		Adjusted dimensional average	Dimensional standard deviation
		SMA	Standard Deviation	SMA	Standard Deviation		
Control	25	10.68	3.6597	13.64	2.76707	13.342	.229
Experimental	25	9.96	3.1686	15.84	3.3126	16.138	.229
Total	50	10.32	3.40732	14.74	3.21863	14.74	.161

Table (1) shows an apparent variation in the arithmetic means, standard deviations, and adjusted means for the achievement of fifth-graders in the science subject due to the difference in the categories of the group variable (experimental, and control), where the arithmetic mean of the experimental group for the pre-test (9.96), and the standard deviation of 3.1686, whereas the mean for the control group in the pre-test was (10.68), and the standard deviation for this group was (3.6597), meaning that the apparent variance in the mean of the two groups for the pre-test was (0.72).

Table 1 also shows a clear variation in arithmetic means, standard deviations in the achievement of basic ninth graders in earth and environmental sciences due to the different categories of group variable (experimental, control) in the post test, where the experimental group's arithmetic mean (15.84) and the standard deviation for this group (3.3126), while the arithmetic mean of the control group was (13.64), and the standard deviation of this group (2.767). This indicates an apparent variation in the mean between the two groups (2.2).

To find out whether there were statistically significant differences at the level of (α=0.05) between the arithmetic mean of the experimental and experimental groups in the pre and post achievement test, and in order to isolate the statistical differences between the two

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groups on the pre-test if any, the adjusted means were extracted as they reached for the experimental (16.138) and to the control (13.342), then the One Way ANCOVA was used on the post-test. Table (2) shows the results of the analysis using the SPSS program.

Table (2). Results of the one-way ANCOVA variance analysis of the group's effect on the achievement of ninth graders in the subject of earth and environmental sciences in the post test

Source of contrast	Sum of squares	Degrees of freedom	Means squares	Statistic value (Q)	Statistical significance	Effect size
Pre-test (Accompanying)	386.057	1	386.057	297.15	.000 *	.863
Way	96.644	1	96.644	74.387	.000 *	.61
error	61.063	47	1.299			
Adjusted total	507.620	49				

* At the significance level (α=0.05)

The statistical results shown in Table (2) indicated that there is a statistically significant difference between the two experimental groups (that were taught using AR technology) and the control (which was taught in the traditional way) at the level of (α=0.05), on the post achievement test, where the calculated value of "F" was (74.387) and statistically significant at (α=000), and the differences were in favor of the experimental group, with the mean of (16.138) which is higher than the adjusted arithmetic mean of the control group's performance (13.342).

To reveal the extent of the effectiveness of using augmented reality technology to teach a unit of study in earth and environmental sciences in the achievement of the ninth-grade students, an ETA box was used to measure the effect size, which was (0.613), meaning that 61.3% of the variance in performance is due to the method of teaching using reality technology Enhanced.

Discussion

The results indicated that there is a statistically significant difference at the level of (α = 0.05) between the scores of the students of the experimental and control groups between the arithmetic means, on the post achievement test, for the performance of the ninth-grade students in the subject matter of the Earth and the pre and post environmental sciences for all sub-levels, and the differences were in favor of the Experimental group.

The results of this study are consistent with the results of (Al-Dahshy, 2017) study, where the results of the study confirmed that augmented reality technology helps to identify the subject of the lesson, and that augmented reality technology helps to increase students' cognitive abilities. It is also consistent with the results of the 2018 Study (Ghalib, Norden), which highlighted the role of augmented reality technology and the importance of its use in learning.

The researchers justified this finding that the use of an augmented reality environment in teaching has broken the routine of students based on the use of the traditional method of non-interactive methods due to images, graphics and videos that attract and enhance their motivation towards learning, where the teaching process through augmented reality attracts students and their eagerness to study, that works to establish information better than it is. That definitely worked on their enthusiasm for learning using this technology, which increases their education.

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This result is consistent with (Mahmoud et al., 2020) study, where it showed differences between the experimental group and the control group and in favor of the experimental group.

Recommendations and Proposals
1. Using augmented reality technology for students at all age levels.
2. Using augmented reality to enrich science curricula.
4. Conducting more studies on augmented reality technology.

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