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THE EFFECT OF VIRTUAL REALITY GLASSES ON ACQUIRING SCIENTIFIC CONCEPTS IN SCIENCE FOR FIFTH GRADE PRIMARY SCHOOL STUDENTS

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Abstract
The current research aims to investigate the effect of virtual reality (VR) goggles on the acquisition of scientific concepts in science for fifth-grade primary school students. To achieve this, the researchers formulated the following null hypothesis: "There is no statistically significant difference at the significance level between the mean scores of the experimental group students, who study using (Virtual Reality Goggles), and the mean scores of the control group students, who study using the conventional method, in the scientific concept acquisition test for the science subject."
The research community was purposively identified as Al-Saif Al-Arabi School. The current research community consisted of all 60 fifth-grade primary school female students at Al-Saif Al-Arabi School, affiliated with the General Directorate of Education of Rusafa First, for the academic year (2024–2025). The students were distributed across two sections, (A and B). Section (A) was randomly chosen, with each section comprising students, to represent the experimental group, while Section (B) represented the control group. The researchers prepared a Scientific Concept Acquisition Test as the research tool, consisting of items based on the processes of concept acquisition. The researchers confirmed the validity of the test by presenting it to a group of experts and calculated its reliability using the Kuder-Richardson formula.
The researchers employed statistical methods including (the t-test for two independent samples, Chi-square test, difficulty, ease, and discrimination coefficients, and the Kuder-Richardson formula). Using the t-test for two independent samples, the results revealed a statistically significant difference between the experimental group (who studied using Virtual Reality Goggles) and the control group (who studied using the conventional method), in favor of the experimental group.

Chapter One
The Research Problem

Science education is an essential need, not a luxury, in light of the significant technological and cognitive advancement of the current century. Societies' focus on science education, along with methods and techniques that reflect the nature of these subjects, has helped in graduating generations armed with knowledge, skills, and values. The science subject itself has become a driver of progress, development, and growth in societies (Al-Balushi et al., 2009, p. 12).
The researchers identified the research problem through field visits to several primary schools and attendance at science classes for the fifth grade. During these visits, they met with science teachers in the primary stage and observed the reality of science teaching. The researchers distributed a questionnaire to a number of male and female science teachers, which indicated that the majority of them use traditional teaching methods.
In light of this, the current research problem is highlighted in the following question:
What is the effectiveness of employing Virtual Reality (VR) goggles in acquiring scientific concepts in the science subject for fifth-grade primary school students?

Importance of Studying

Education in the modern era has undergone a radical transformation due to modern technologies, where technology has become a key tool for developing teaching methods, improving educational quality, and enhancing the effectiveness of the educational process. These technologies have contributed to providing interactive learning environments and enabling teachers and students to access knowledge more efficiently and flexibly (Sabri, 2009, p. 147).

Virtual Reality Headsets (VR) are the main gateway to entering immersive digital worlds. They are not merely display screens but devices specifically designed to provide an integrated sensory experience that separates the user from their physical reality and transports them to artificial virtual environments, whether they are simulations of reality or entirely fictional worlds (Jerald, 2016, p. 30). This technology has moved beyond being a mere entertainment tool to become a powerful instrument with wide applications in education, training, healthcare, design, and much more.

VR goggles have created a paradigm shift in how we interact with digital content, offering immersive experiences that were not previously possible. From recreational games to precise surgical training, innovative education, and psychological therapy, this technology proves its ability to change various aspects of our lives. Despite challenges like cost, comfort, and content development, continuous advancements in hardware and software promise a future where VR goggles become an integral part of our daily lives, opening doors to new worlds of knowledge, learning, and entertainment (Hussein, 2020, p. 22).

The researchers believe that VR goggles have revolutionized teaching and training methods by providing immersive and realistic experiences that are difficult to achieve in traditional environments. VR electronic goggles are a technological tool used to support the educational process, characterized by their ability to deliver content to students.

Based on the foregoing, the importance of the current study arises, and there is a pressing need to research VR goggles further, especially for the primary stage.

From all this, the idea of employing VR goggles in acquiring scientific concepts in the science subject and acquiring basic science processes for fifth-grade primary students emerged, given its significance in the educational process. Its importance is amplified by its reliance on Virtual Reality (VR), helping both the teacher and the student to utilize it in problem-solving and decision-making.

The researchers believe there is no dispute over the importance of teaching and learning concepts for anyone studying science. The literature confirms that scientific concepts are one of the most important levels of the cognitive structure of science, upon which other levels (principles, generalizations, laws, and theories) are built. Concepts are also considered one of the most important learning outcomes through which scientific knowledge can be organized for the student in a way that gives it meaning.

Based on the above, the importance of the current study is highlighted in the following:

The importance of the science subject, which is considered one of the main subjects in the primary stage, as it prepares students in several aspects.

The importance of scientific concepts, as they are the foundation for understanding the scientific content of the subject matter, elevating learning to a high degree of progress.

The importance of employing VR goggles in acquiring scientific concepts in the science subject.

Research Objectives

The current research aims to:

Identify the effectiveness of employing Virtual Reality (VR) goggles in acquiring scientific concepts in the science subject for fifth-grade primary school students.

Research Hypotheses

To achieve the research objective, the researcher formulated the following null hypothesis:

There is no statistically significant difference at the 0.05 level between the scores on the scientific concept acquisition test for the science subject for the students in the experimental group who study according to Virtual Reality goggles and the scores of the students in the control group who study according to the conventional method.

Research Delimitations

The current research is limited by the following:

Schools under the Directorates of Baghdad Governorate for the academic year 2024/2025.

Fifth-grade primary school students in primary schools in Central Baghdad.

A number of topics from the prescribed science textbook for the fifth primary grade.

Definitions of Terms

Here are the definitions for Concept Acquisition (Concepts Acquire) as presented in the text, along with the researchers' operational definition:

1. Definition by Abu Jado (2015)

Saleh Abu Jado, in his book *"Learning and its Theories"*, defined Concept Acquisition as:

"A complex mental process in which mental categories are built and abstract ideas are formed, which are considered the basis for thinking, abstraction, and problem-solving in the individual." (Abu Jado, 2015, p. 120)

2. Definition by Al-Zayat (2016)

Fathi Mustafa Al-Zayat, in his book *"Learning Theories"*, defined Concept Acquisition as:

"The process by which the learner **infers common characteristics** among a set of stimuli or situations, in order to **generalize** these characteristics to new, similar stimuli and situations that they have not previously dealt with." (Al-Zayat, 2016, p. 155)

3. Operational Definition by the Researchers

The researchers operationally defined Concept Acquisition as:

The ability of the fifth-grade primary students in the experimental group to acquire new scientific concepts, link them to previous scientific concepts in the learner's memory, and then employ them in a new way in new life situations through Virtual Reality goggles.

Chapter Two: Theoretical Aspects and Previous Studies

This chapter establishes the theoretical foundations for this research by reviewing the relevant elements, defining its frameworks, and discussing the material presented in related sources and literature. This helps to reinforce, enrich, and address the study from a scientific educational perspective. The theoretical aspects of any research consist of two main bases: Previous Studies and the Theoretical Framework.

Theoretical Aspects: Virtual Reality Goggles and Their Development

Origin and Evolution of Virtual Reality Goggles

The concept of Virtual Reality (VR) Headsets began in the 1960s with rudimentary innovations, such as the "Sword of Damocles" designed by Ivan Sutherland. However, it didn't enter practical use until the early 21st century. Advances in graphics and motion tracking technologies facilitated the development of more precise and immersive goggles.

The commercial interest in VR surged with the launch of headsets like the Oculus Rift in 2012, followed by models such as HTC Vive and PlayStation VR.
Modern goggles are characterized by high display quality and accurate tracking of head and eye movements, which fully enhances the VR experience.
Currently, these headsets are entering numerous sectors, most notably education, entertainment, and healthcare (Dhanush & Barath, 2025, p. 12).

Technology and Mechanics

VR goggles rely on complex technologies, including high-frequency display screens, tracking sensors (Inertial Measurement Units), spatial positioning systems, and powerful graphics processors.
These components integrate to generate a realistic three-dimensional visual experience, where the virtual content responds instantly to the user's movements.
Eye and focal field tracking technologies are used to enhance scene depth and reduce eye strain.
Devices like the Meta Quest 3 and Apple Vision Pro are examples of advancements in design and comfort.
Companies strive to produce lighter, more interactive goggles by integrating Artificial Intelligence (AI) and Mixed Reality (Dhanush & Barath, 2025, pp. 13–14).

Role in Primary Education

VR goggles are considered an innovative educational tool in primary classrooms, allowing children to engage in interactive learning experiences such as virtual trips to planets or viewing science experiments in 3D technology, which enhances understanding and retention.
Students can explore plant cells or the human heart in a tangible visual manner, which is difficult to achieve in traditional classrooms.
This technology also supports children with special needs through personalized and adaptive learning experiences.
Studies have shown that using VR in primary classrooms improves academic performance and increases classroom interaction (Dhanush & Barath, 2025, p. 15).

Technical Challenges

Despite the astonishing development, VR goggles face several technical challenges:
High cost, battery issues, high device weight, and the impact of long-term use, such as eye strain and dizziness.
Latency is a major constraint; a delay in response can cause a loss of the sense of immersion and may even lead to nausea in children.
Tracking devices may fail in environments with poor lighting or reflective surfaces.
Goggles require improvements in terms of operating environment, ergonomic design, and processor efficiency to be suitable for younger school students (Dhanush & Barath, 2025, pp. 14–15).

Components of a Virtual Reality Headset

VR goggles consist of a set of technical components designed to provide an immersive experience for the user. These components rely on the integration of visual, auditory, and kinetic elements to create a highly realistic virtual environment:
High-Resolution Display Screens: These screens, typically OLED or LCD, are placed in front of each eye. Two images are displayed at different angles to create a sense of depth and 3D vision.
Lenses: Convex lenses are positioned between the screen and the eye. They focus and magnify the image to match the human field of view, adjust to minimize visual distortion, and are essential for visual comfort during long usage.

Tracking Sensors: The headset includes a set of sensors like the Gyroscope, Accelerometer, and Magnetometer. These are responsible for tracking head movement in real-time, allowing the virtual scene to update instantly according to the viewing angle and movement direction.
Audio System: Many goggles feature built-in headphones or an audio jack for external headphones, providing 3D Spatial Audio that enhances the sense of immersion and increases user interaction with the virtual environment.
External Cameras (Optional): Some goggles include external cameras to monitor the real environment, allowing for the integration of Augmented Reality or the tracking of hand movements and the user's position within the room, as seen in devices like the "Meta Quest Pro" and "HTC Vive XR Elite."
Processing Units and Battery: Modern goggles include integrated processing units that allow applications and games to run without the need for an external computer. They also contain storage memory and built-in batteries for freedom of movement.
Controllers or Hand Tracking: Some headsets come with hand controllers equipped with sensors to track hand movement and provide a deeper interactive experience. Alternatively, some can use optical hand tracking instead of controllers.

Chapter Two: Theoretical Aspects and Previous Studies (Continued)

Types of Virtual Reality Headsets

Virtual Reality (VR) headsets are categorized into three main types, which differ in their technical structure, capabilities, and degree of independence. This makes each type suitable for a specific user segment depending on the purpose of use and the technical and financial resources available.

1. Standalone VR Headsets: This category is the most widespread currently because these headsets operate independently without needing to be connected to a computer or a smartphone. They contain internal processors, storage memory, a display screen, and a battery, making them usable anywhere without restrictions. Famous examples include the Meta Quest 2 and Meta Quest 3. They are characterized by ease of use, freedom of movement, and the integration of entertainment, educational, and training applications. Sherman and Craig pointed out that Standalone headsets are distinguished by having "all display, processing, and tracking components within a single device," making them the optimal choice for regular users and mobile environments (Sherman & Craig, 2018, p. 93).

2. PC-Tethered VR Headsets: These headsets rely on a direct connection to a powerful computer via a USB-C or HDMI cable. They offer the highest display quality and graphical performance, and are often used in advanced gaming, engineering design, and realistic simulations such as pilot or surgeon training. Prominent examples include the Valve Index, HTC Vive Pro 2, and Pimax. Despite their superior performance, they require a computer with high specifications and connecting cables, which reduces flexibility of movement. According to LaValle, these headsets "provide the best graphical performance, but they require advanced infrastructure including computer hardware and external sensors" (LaValle, 2016, p. 221).

3. Mobile VR Headsets: These headsets are designed to work by inserting a smartphone into a dedicated slot inside the goggles. The phone is used as the screen and processor to run VR applications. Famous former models include Google Cardboard and Samsung Gear VR. They are the cheapest and simplest of the three types, but are limited in quality, resolution, and motion response. They are often used for simplified educational purposes or quick virtual showcases. Bowman and McMahan noted that "reliance on the smartphone in this type of headset limits interactive

capability and display quality, but it represents an affordable gateway to the VR experience" (Bowman & McMahan, 2005, p. 41).

The researchers believe that Virtual Reality headsets have created a qualitative leap in how we interact with digital content, offering immersive experiences that were not possible before. From recreational games to precise surgical training, through innovative education and psychological therapy, this technology proves its ability to change various aspects of our lives. Despite the challenges of cost, comfort, and content development, continuous developments in hardware and software promise a future where VR headsets become an integral part of our daily lives, opening doors to new worlds of knowledge, learning, and entertainment.

Previous Studies

Studies Addressing the Effectiveness of Employing Virtual Reality

Chen Study (2013): The study aimed to identify the effect of employing Augmented Reality (AR) and its ability to facilitate learning "earthquake prediction" technology. The study was conducted in the United States, used the experimental method, and the researcher selected a sample of (96) students. To achieve the study's goals, a self-efficacy scale and an achievement test were prepared. The results showed that the performance of the group of students who studied using Augmented Reality technology was better than the performance of the students who studied using the conventional method on the achievement test.

Morales Study (2018): The study aimed to determine the effect of using Augmented Reality on students' academic performance. The study was conducted in Spain, used the experimental method, and the researcher selected a sample of (39) students. To achieve the study's goals, an achievement test was prepared. The results revealed that students who used Augmented Reality had better academic performance.

The researchers, after reviewing the previous studies, believe that Virtual Reality has a significant positive impact on students' learning in education, especially in the acquisition of concepts, knowledge, and practical skills, and it increases their motivation.

Chapter Three

Research Methodology and Procedures

This chapter presents the **research methodology** in terms of selecting the experimental design, defining the research population and sample, establishing **equivalence** between the research groups (experimental and control), preparing its prerequisites and instrument, applying the experiment, and selecting the **statistical methods** for appropriate data processing, as follows:

First: Experimental Design:

Given that the current research has one **independent variable**, which is the **strategy (Virtual Reality Glasses)**, and one **dependent variable**, which is the **(Acquisition of Scientific Concepts)**, the researchers adopted a **partially controlled experimental design** for two groups (experimental and control) with a **post-test** to measure the acquisition of scientific concepts. The experimental design can be expressed as shown in the following figure:

Group	Equivalence	Independent Variable	Dependent Variable	Post-Test
Experimental	Chronological Age in Months Intelligence Previous Achievement in Science	Virtual Reality Glasses	Acquisition of Scientific Concepts	Acquisition of Scientific Concepts
Control		Traditional Method		

Figure (1) The Experimental Design of the Research

Second: Research Population and Sample:

The research population, (Al-Saif Al-Arabi School), was purposively selected. The current research population consisted of all (60) fifth-grade primary female students from (Al-Saif Al-Arabi School), affiliated with the General Directorate of Education of Rusafa Al-Oula, for the academic year (2024–2025). They were distributed into two sections: (A and B). Section (A) was randomly selected, comprising (30) students to represent the Experimental Group, and Section (B) represented the Control Group.

Third: Equivalence of the Two Research Groups in the Following Variables:

Chronological Age in Months:

Previous Achievement in Fourth-Grade Science:

Intelligence: The result showed that both groups were equivalent for all these variables.

Fourth: Research Requirements and Information Sources:

Defining the Educational Material:

Behavioral Objectives for the Content of the Educational Material:

Educational Aids/Media:

Teaching Plans:

Fifth: Research Tool:

A requirement of the research was to construct a test to measure the acquisition of scientific concepts (Definition, Discrimination/Distinction, Application). The goal was to determine the effect of the teaching method on the experimental and control groups. The following is a detailed presentation of the procedures for preparing the research tool and the stages of its development. (Sabry, 2019, 164).

Scientific Concept Acquisition Test:

The preparation of the test went through several stages:

Preparation of Test Items:

Test Validity:

Test validity is one of the important factors concerning test quality standards (Brown, 1981, p: 254). Al-Imam et al. (1990) mentioned that the validity of a test is one of the matters the test designer must ensure when constructing their test, ensuring the test measures the phenomenon intended for study (Al-Imam et al., 1990, p: 123). To verify the test's validity, Content Validity and Construct Validity were verified as follows:

Content Validity

Construct Validity

Pilot Study:

Test Reliability:

Sixth: Application Procedures:

Procedures for the Application of the Experiment:

In order to maintain the research's experimental design and reach its results, the researcher took the following precautions:

The researcher began work at the school on Monday, (October 7, 2024), and the weekly teaching hours for the experimental and control groups were on the same days, with three periods per week.

The duration of the experiment was the same for both the experimental and control groups. The research experiment began on Tuesday, (October 8, 2024), and ended on Wednesday, (January 15, 2025), upon completion of teaching the targeted units from the prescribed textbook. The research tool was applied on Thursday, (January 16, 2024), to both the experimental and control groups.

Both the experimental and control groups were given the same educational material to ensure equality between the groups in terms of the information they were exposed to. The same amount of homework, classroom exercises, and educational aids was also given.

The researchers themselves conducted the teaching for the pupils in both groups. This was done to avoid any variation that might arise from differences in the science teacher's familiarity with the nature of the experimental variable when teaching each group. Furthermore, the researcher himself prepared the experiment's requirements, including the conceptual analysis and identification of the content of the educational units, the formulation of their behavioral objectives, the preparation of the teaching plans, the educational aids, the research tool, and all other requirements.

The same educational aids, such as posters, models, figures, etc., were used in teaching both research groups.

There were no cases of pupils transferring between the two groups during the experimental period, and no pupil attended except with their assigned group.

Seventh: Statistical Means:

The researchers used the Statistical Package for Social Sciences (SPSS) in their research procedures and data analysis.

Chapter Four

Presentation and Interpretation of Results:

This chapter includes a presentation of the results reached through the statistical treatments in accordance with the adopted research hypothesis, an interpretation and discussion of these results, along with a statement of the conclusions, recommendations, and future proposals emerging from the current research, as follows:

First: Presentation of the Result

To verify the hypothesis which states:

("There is no statistically significant difference at the significance level of (0.05) between the mean scores of the experimental group students studying according to (Virtual Reality glasses) and the mean scores of the control group students studying according to the conventional method in the post-test for concept acquisition in Science subject").

The researcher administered the post-test for concept acquisition, consisting of (30) items, to both the experimental and control groups. To identify the difference between the mean scores of the two groups, the researcher used the t-test for two independent samples. The results were as shown in Table (1):

Table (1)
Results of the t-test for two independent samples for the post-test of concept acquisition

Variable	Group	Number	Mean	Standard Deviation	t-Value (Calculated)	t-Value (Tabulated)	Significance Level (0.05)
Post-Concept Acquisition	Experimental	30	32.39	3.774	4.356	2.00	Statistically Significant
	Control	30	28.62	4.350			

It is evident from the table above that there is a statistically significant difference between the experimental group (studying with Virtual Reality glasses) and the control group (studying with the conventional method), and the difference is in favor of the experimental group. This is because the calculated t-value of (4.356) is greater than the tabulated t-value of (2.00) at the significance level of (0.05). Figure (13) illustrates the difference between the two groups.

The Magnitude of the Effect (Effect Size)

The magnitude of the effect is defined as the difference between the means of the experimental and control groups for the post-test of concept acquisition, divided by the standard deviation of the control group. Knowing the effect size helps us determine the relative magnitude of the effect of a particular educational treatment. To determine the level of the effect, there is a standard where:

Low Effect: Between 0.20 – 0.40.

Medium Effect: Between 0.41 – 0.60.

High Effect: From 0.61 – and above. (Allam, 1989: 155)

Effect Size Result

After applying the (Glass) equation, the effect size was as follows:

The effect size for the post-test of concept acquisition reached (0.87). Therefore, the effect size of the (Virtual Reality Goggles) method on the post-test of concept acquisition is considered high.

Second: Interpretation of the Result

After reaching the previous result, a difference was found between the mean scores of the scientific concept acquisition test for the two research groups (experimental and control), and the difference was in favor of the experimental group which was taught using the (Virtual Reality Goggles). The researchers believe this result is due to several reasons, including:

Virtual Reality Goggles helped stimulate critical thinking among the students.

Virtual Reality Goggles helped increase students' motivation towards learning.

Third: Conclusions

Based on the results reached by the researcher in the current study, which were presented previously, the following conclusions are presented:

Virtual Reality Goggles contributed to the easy acquisition of scientific concepts for the science subject among students.
Teaching according to Virtual Reality Goggles led to exciting the students and increasing their motivation in their acquisition of scientific concepts.

Fourth: Recommendations

The researchers recommend that educational institutions use Virtual Reality Goggles in schools for teaching students.

Fifth: Suggestions

At the end of this chapter, the researcher presents the following suggestions based on what was achieved in the current study:
A study of the effect of Virtual Reality Goggles on the academic achievement in science for students in other grade levels.

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