# AUGMENTED REALITY AIDED TEACHING CHEMISTRY FOR STANDARD VII STUDENTS AND THEIR ACHIEVEMENT

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### *ABSTRACT*

*More than ever, there is a demand for technology that improves conventional educational delivery methods. This can be helped by contemporary advancements like augmented reality. With the use of AR, VR, and MR technology, teachers can create classes that link images to reality and students have access to visuals that can improve their learning. Technologies like this offer a method of disseminating information that makes learning interesting and clear for teachers [6]. The Objective of this study was to compare the effectiveness of conventional teaching of chemistry Vs teaching assisted by augmented reality in chemistry. The study's goals were to determine whether augmented reality-assisted instruction improved seventh-grade students' performance in chemistry. The sample size consisted of 88 students from standard VII. Purposive Sampling Technique was used for this study. The research was exploratory in nature. Students were divided randomly into experimental and control groups based on the academic performance of Standard VI in the science curriculum. After the experiment, a self-created achievement test was administered. The difficulty level and discriminative index were taken into consideration when choosing the achievement test items. According to statistical analysis, the experimental group's outcomes greatly outperformed those of the control group in terms of student success. Using augmented reality technology, students were able to accomplish more and clear up any misconceptions [12].*



***Keywords:*** *Augmented reality technology, conventional teaching, achievement in chemistry, VII standard students.*



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## I. Introduction

The entire educational system has been dramatically transformed by modern technology. Everyone who wants to learn has now access to education owing to the technologically enhanced classrooms through the internet, at any time, in any subject, and from anywhere. The potential of the classroom is boundless. Any number of students can access the virtual classrooms, in contrast to real classrooms, which have a capacity of maximum of sixty. There is an infinite quantity of knowledge available for learning, either for free or at a price that is within reach of the common man. Learning has become more interactive and collaborative as a result of the use of contemporary technology in education such as augmented reality, virtual reality, and artificial intelligence [10].

There is little knowledge of how computer-based technology can be used to foster high order thinking, develop communication, and student engagement, a concept receiving significant attention in education due to its association with a number of beneficial academic outcomes. Computer-based technology has permeated many aspects of life and industry [11]. Another study supports the idea that using contemporary technology in the classroom enhances student motivation. Carefully planned and well-executed network science projects also have the potential to help students develop strong motivational beliefs and understand what it means to learn and practice science [8]. A kind of technology known as augmented reality (AR) involves continuously superimposing computer-generated virtual visuals over real-world ones. This increases access to information and opens up new potential for engagement [3]. AR technology superimposes entities that don't exist in the actual world but only on device screens by using the camera, location-based services, internet, graphics, visuals, audio elements, and more. Through videos, graphics, and interactive elements on the screens of students' devices, augmented reality (AR) can do wonders in education by bringing to life some of the most challenging concepts and subjects like Rutherford experiments, uncertainty principles, biological processes, World War II, and more [6].

## II. AR in Chemistry

Students were assisted with the 3D spatial visualization of molecules and their chemical reactivity using a combination of three related approaches, such as 3D modeling, animation, and augmented reality (AR) [1]. Children start studying chemistry when they are 14 years old, and some subjects seem to be challenging for them to understand. The software is created around lively, instructive graphic components as a consequence, which facilitate and improve the learning process.

The AR Chemistry Learning app is easy to use and can be downloaded to a phone or tablet. The main structure of this programme is augmented reality. The core of this application, which integrates the idea of online learning, is augmented reality (AR). Virtual objects, in this case represented by molecules with accurate volume and colour, can be interacted in using augmented reality (AR). They are made visible by the markers, which simulate a piece of paper containing instructional material that the camera can view. The technology was utilised by both Unity and Vuforia. The four primary modules that will be examined are: Learn using the manual, Learn with cards, Test your knowledge, and Add a substance. The growing AR industry has the potential to completely transform learning in a variety of fields. With so much promise to revolutionize learning in many fields, augmented reality is blossoming right now. We discuss the value of the visual channel in the chemical learning process in order to facilitate different learning styles. Chemistry AR Children's and students' natural interest is piqued by learning, which also fosters reasoning and encourages hands-on learning of chemistry. AR applications help traditional teaching methods by drawing in more students to the classroom. In fact, children are more likely to remember new knowledge when it is presented visually. AR-based tests can help kids feel less anxious. The contact between students and lecturer is enhanced by this application [9]. On the immediate posttest's interest questionnaire and chemical processes concept test, the hands-on learning group considerably outperformed the demonstration learning group. Retention effects also showed that four months after the learning sessions were finished, the students' conceptual knowledge of chemical elements was still useful [5]. A technical assistance that links automatically two-dimensional (2D) chemical structure representations and three-dimensional (3D) molecular visuals in order to facilitate spatial learning. For the purpose of identifying the structure and creating a 3D model, the image of a chemical structure is captured and analysed instantly. Students have struggled to comprehend spatial processes, spatial structures of molecules, and model perception because traditional teaching strategies do not adequately support student comprehension [7]. With the use of augmented reality technology, students may simulate chemical experiments in a way that feels natural [14].

***A. Need for the Development of AR***

Learning opportunities are crucial for the growth of a student's life cycle, and they should be exciting and motivating to keep students interested. Chemistry is a fascinating subject, but it can be challenging for students to understand all of its concepts. Additionally, the student finds it challenging to comprehend how bonds like ionic bonds, covalent bonds, coordinate covalent bonds, and polar links are formed as well as the structure of molecules and atoms. In a similar vein, pupils struggle to understand many chemical types as well as varied complex experiments. A better way to learn and understand chemistry is through augmented reality. Teachers can explain complex concepts with ease by presenting the improved experiments. It is the teacher's responsibility to foster and pique student interest in the subject matter because they are aware that learning should be centred on creativity and involvement. Nowadays, most young individuals have smartphones. These people have smart phones and use them to play games, access social networking sites, and keep in touch with friends and family. Young students also utilize smartphones and computers for academic purposes, including doing homework, researching a topic, playing 3D games, watching animated films, and other activities. We can infer that 3D pictures are appealing to both children and adults since we live in a three-dimensional world.

By overlaying digital data directly onto real-world objects or situations, augmented reality eliminates the need for people to mentally bridge the gap between the actual and the digital, enabling simultaneous processing of both. The use of augmented reality (AR) in the classroom can make learning more exciting and participatory by allowing teachers to present visual examples of concepts and include gaming aspects to support textbook material. As a result, students will be able to acquire and recall knowledge more quickly. Human memory makes it tough to forget visuals.

An instructional tool based on augmented reality created for school children to make learning enjoyable and simple while covering difficult subjects. Additionally, it will make it simpler for the teacher to explain challenging chemistry concepts. Using augmented reality, students may see a molecule from all sides, imagine how atoms are arranged in an element, and comprehend more complex chemical concepts. Therefore, it is necessary to create augmented reality for chemistry molecules for teaching.

## III. Developmental Process of AR

There are various varieties of augmented reality, including marker-based, markerless, location-based, superimposition-based, projection-based, and outlining-based versions. For this investigation, the researcher used marker-based AR. It offers markers that can start an enhanced experience. The anchors for this technology are the markers, which are frequently created with distinctive patterns like Image Target or other distinctive designs. An augmented reality application overlays digital content on top of a marker in the real world when it detects the marker.

### *A. Installing Software*

The researcher utilized Google to look up Vuforia, then proceeded to the Vuforia Development Portal to get a license key and download the 10.3 version of the Vuforia Engine. The researcher logged in at the Vuforia Development site. The researcher then fixed the targets in Target Manager before using Paint to create the images. The first box was created using the colour black or grey, and then the image was added before being saved. The researcher first clicked Add target, then a single image. The researcher was then taken to his or her browser after clicking file, where he or she obtained the image's location and picked it. The developer has selected the image's width. then clicked the image's width. Once the image was clicked, its width was displayed as a dimension. length entered. The name was then entered. Consider salt. The researcher once more clicked Add. The researcher then chose "download database" to proceed. After typing Unity Hub into Google, the researcher clicked Download Unity Hub. After downloading and installing Unity Hub, click Save. Click I accept after opening the Unity Hub installation. The experimenter set up the Unity Editor 2020.3.22.F1 programme. On the left side of the screen, the researcher clicked Projects, and then he or she selected New Project. The researcher selected 3D Core and typed Test 2 into the field provided. Opening it takes some time. The page was then opened. The toolbar to Assets, was selected by the researcher. After that, the researcher chose Import Package. The researcher visited the Vuforia Development Portal once more and chose Downloads. The researcher downloaded Vuforia after selecting and clicking Add Vuforia to Unity Projects. the procedure where the researcher uploaded the package was repeated. then clicked Custom package after selecting Import package. The next page displayed the download option. The researcher made a Package choice. It started. Left mouse button clicked, Vuforia Engine was selected, and AR Camera was selected. The researcher opened Vuforia, selected Develop, then clicked License Manager before selecting Get Basic. Vuforia Engine was selected by the researcher. The Image Target was then chosen and loaded. The researcher clicked Image Target Behavior on the inspector window's right side. The researcher chose Database and then clicked. clicked sphere, 3D object, and cylinder after clicking 3D object. The cylinder was put close to the Sphere (Figure-1). The researcher then chose the Scale tool, adjusted the cylinder's size, and placed it next to the sphere. The researcher then generated a second sphere for a molecule, placed it close to the cylinder, and made sure the cylinder was connected by two spheres. It was possible to see the molecule (Figure-2).

**Figure 1 Cylinder close to Sphere**

**Figure 2 Cylinder connected by two Spheres**

The researcher went to Paint and chose the colour and filled it and used an Alphabet to create the symbol, then dragged the Symbol picture to Unity Assets (Figure-3).The researcher dragged the image and pasted it on that and put it on the sphere and placed the molecule on the Image Target and then the size was checked and adjusted.

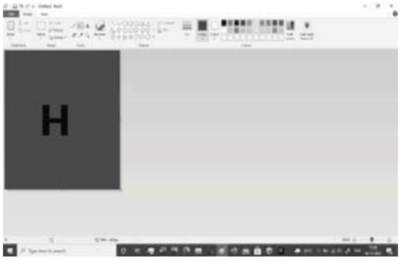


**Figure 3**

The researcher clicked Scale 2 and adjusted the size of the atom and then selected Sphere, Cylinder and Sphere(1) and dragged it to the Image target. AR Target was ready. AR ImageTarget developed by the researcher for molecules such as oxygen, Chlorine, Nitrogen, ozone, water, carbon-di-oxide, Ammonia, Hydrogen Chloride, Sodium Chloride (Figure-4) and pictures for metals, non-metals, metalloids and atomic structure for elements such as Helium, Hydrogen, Nitrogen, Oxygen, Sodium, Aluminium, beryllium, boron, Calcium, Glucose and Ethanol. Thus, the molecules, elements, pictures were ready to view by augmented reality (Figure-5) using AR camera.


**Figure 4 (image target for Salt)**

**Figure 5 (Augmented reality view of NaCl)**

## IV. Methodology

***A. Objective of the Study***

1. To find out the effectiveness of Augmented reality aided teaching chemistry for Standard VII students.

***B. Hypotheses of the Study***

1. There is no significance difference between post-test with regard to control group and experimental group of Standard VII students.
2. There is no significance difference between Delayed post-test with regard to control and experimental group of Standard VII students.

***C. Design***

For this study, the Posttest-Only, Equivalent Groups Design was used. At Christhuraja Higher Secondary School in Palayamkottai, Tirunelveli, Tamil Nadu, three sections were randomly chosen to represent a sample of 88 students in the VII grade. For the study, purposeful random sampling procedures were used. From a school population of 100 VII Standard Tamil medium students, the researcher randomly picked the pupils based on the annual marks in science. The experimental and control treatments are randomly assigned to the 88 students, with 44 serving as the experimental group and 44 as the control group. The experimental group receives augmented reality instruction in chemistry concepts. The same principles are taught using the chalk and talk method to the control group.

***D. Tool***

***a) Preliminary Try-Out:***

The researcher created an Achievement Test in Chemistry for students in the VII Standard in order to conduct post-test and retention tests. Based on the Revised Bloom's Taxonomy of Educational Objectives, multiple choice questions were created from the chosen sections. The language of the items was improved, and the questions' confusion was eliminated, making it easier for the students to understand the questions. The topic specialist in the area of teaching chemistry received the prepared questions. The questions were revised and reframed in light of the expert's advice. Thus, a sample of 15 eighth-grade kids were given the 75 questions that had been carefully analyzed. Correct responses received one mark, while incorrect responses received zero marks. The researcher prepared weight age tables.

**Table 1 Weight age to objectives of the preliminary draft of achievement test in chemistry**

| Objectives | Marks |
|---|---:|
| Remembering | 23 |
| Understanding | 25 |
| Application | 14 |
| Analysis | 13 |
| **Total** | **75** |

***b) Try Out:***

At this stage the Achievement test in Chemistry was administered to 120 VIII Standard Students.

***c) Item Analysis:***

There are two categories that make up item analysis. (1) Level of difficulty (2) Discriminative Index The researcher used the steps to carry out the item analysis. The scored response sheets were grouped in descending order of performance. For item analysis, the top 27% and the bottom 27% of the scores were taken into account. Items with difficulty levels ranging from 30% to 80% and discrimination indices ranging from 0.3 to 0.8 were chosen for the current study. For the final Achievement test, 50 items were ultimately chosen. The final version of the Chemistry Achievement Test's weighted scoring system was prepared.

**Table 2 Weight age to objectives of the final draft of achievement test in chemistry**

| Objectives | Marks |
|---|---:|
| Remembering | 13 |
| Understanding | 18 |
| Application | 11 |
| Analysis | 8 |
| **Total** | **50** |

***a) Phase I: Administration of the Screening Test:***

The sample individuals were contacted and a rapport built with them before to the experiment's start. To assess their prior chemistry expertise, the researcher quizzed them. Students were in lockdown because of the Covid-19 pandemic crisis. Only the third trimester saw the arrival of students. In the third term units, they were familiar and able to respond, but they couldn't recall the term I and term II units. As a result, neither group received a pre-test from the researcher. After that, to help the pupils overcome their worry and curiosity, orientation and instructions on the treatment that would be given to them were given to both groups of students.

***b) Phase II: Executing the Experiment*:**

The second stage of the experiment was when the experiment was actually carried out. In this phase, the experimental group of students received augmented reality-assisted instruction, while the control group received traditional chalk-and-talk instruction. Both sets of students received the educational therapy for about one month (24 working days). The pupils were instructed in two Chemistry units from the Standard VII (Term-I) Tamilnadu State Board Syllabus. The Augmented reality view of structure of atom (Figure-6) and Ozone (Figure-7) are given below.

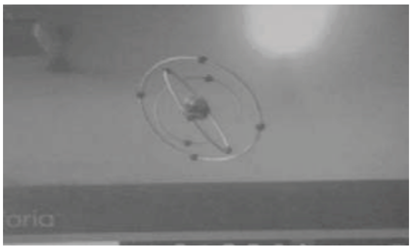

**Figure 6 Augmented Reality view of atom structure**

**Figure 7 Augmented Reality view of view of Ozone**

***c) Phase III: Administration of Retention Test***

After a month, both the experimental group and the control group students took the retention test. Scores on the retention test were recorded.

***E) Statistical Technique used***

To achieve the study's goal, both qualitative and quantitative analyses of the obtained data were performed. For the current study, the researcher used descriptive and differential analysis as a statistical method.

## V. Analysis And Interpretation

**Hypothesis 1:** There is no significance difference between post-test with regard to control group and experimental group of Standard VII students.

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**Table 3 Significance of difference between post test achievement scores of students in control group and experimental group**

| Paired Samples Test | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Paired Differences | | | | | t | df | p value |
| | | Mean | Std. Deviation | Std. Error Mean | 95% Confidence Interval of the Difference | | | | |
| | | | | | Lower | Upper | | | |
| Pair 1 | Control Gp Post test Remembering - Exp Gp Post Test Remembering | -1.500 | 2.328 | .351 | -2.208 | -.792 | 4.274 | 43 | .000** |
| Pair 2 | Control Gp Post Test Understanding - Exp Gp Post Test Understanding | -2.727 | 3.295 | .497 | -3.729 | -1.726 | 5.491 | 43 | .000** |
| Pair 3 | Control Gp Post Test Application - Exp Gp Post Test Application | -1.023 | 2.610 | .394 | -1.816 | -.229 | -2.599 | 43 | .013** |
| Pair 4 | Control Gp Post Test Analysis - Exp Gp Post Test Analysis | -1.545 | 2.140 | .323 | -2.196 | -.895 | -4.791 | 43 | .000** |
| In-Toto | Post Test Control Gp - Post Test Exp Gp | -6.795 | 6.719 | 1.013 | -8.838 | -4.753 | -6.709 | 43 | .000** |

**Significance at 0.05 levels

Since the p value is less than 0.05, the null hypothesis is not accepted at 0.05% level of significance. Hence there is a significant difference between the posttest scores of control and experimental group with regard to learning objectives namely remembering, understanding, application and analysis. The Posttest achievement scores of experimental group students are higher than the control group students.

**Hypothesis 2:** There is no significance difference between Delayed post-test with regard to control and experimental group of Standard VII students.

**Table 4 Significance of difference between delayed post test achievement scores of students in control group and experimental group**

| Paired Samples Test | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Paired Differences | | | | | t | df | p value |
| | | Mean | Std. Deviation | Std. Error Mean | 95% Confidence Interval of the Difference | | | | |
| | | | | | Lower | Upper | | | |
| Pair 5 | Control Gp Remembering - Delayed Exp Gp Remembering | -2.545 | 3.599 | .543 | -3.640 | -1.451 | -4.692 | 43 | .000** |
| Pair 6 | Delayed Control Gp Understanding - Delayed Exp Gp Understanding | -4.136 | 3.428 | .517 | -5.178 | -3.094 | -8.005 | 43 | .000** |
| Pair 7 | Delayed Control Gp Application - Delayed Exp Gp Application | -1.364 | 2.624 | .396 | -2.162 | -.566 | -3.447 | 43 | .001** |
| Pair 8 | Delayed Control Gp Analysis - Delayed Exp Gp Analysis | -2.091 | 1.789 | .270 | -2.635 | -1.547 | -7.752 | 43 | .000** |
| In-Toto | Delay test Control Gp - Delay test Exp Gp | -10.136 | 8.326 | 1.255 | -12.668 | -7.605 | -8.075 | 43 | .000** |

**Significance at 0.05 levels

Since the p value is less than 0.05, the null hypothesis is not accepted at 0.05% level of significance. Hence there is a significant difference between the delayed posttest scores of control and experimental group with regard to learning objectives namely remembering, understanding, application and analysis. In the retention test, achievement scores of Experimental group students are higher than the control group students.

## VI. Findings

1. There is a significance difference between post-test with regard to control group and experimental group of Standard VII students.
2. There is a significance difference between Delayed post-test with regard to control and experimental group of Standard VII students.

## VII. Educational Implications

The study's findings highlight the value of using augmented reality to help standard VII students are learning chemistry. Students are highly motivated, enthusiastic about learning chemistry, and their performance improves. The AR methodology is more effective than the traditional teaching method, especially for students with low achievement levels [13]. Less-achieving kids benefit more from the AR tool's learning impacts than do high-achievers [4]. The real world had been improved by using virtual information, creating new potential for science training to become more meaningful. The findings demonstrated that AR had a significant positive impact on the experimental group's performance, interest, and science-processing skills in all three categories [2].

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