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Impact of Animation Technique on Students Academic Achievement in Chemistry at Secondary Level

Jafer Ali[1], Asma Khan[2] & Dr. Muhammad Aqeel Raza[3]

[1]*Deputy District Education Office, DDEO (EE) Office Jalal Pur Pirwala, Multan, Email: jaffercd@gmail.com*
[2]*MPhil Scholar, Department of Education, NCBA&E, Sub Campus Multan, Email: jafercd@gmail.com*
[3]*Associate Professor, Department of Education, NCBA&E, Sub Campus Multan, Email: razaaqeel06@gmail.com*

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Corresponding Author:
Jafer Ali
Email:
jaffercd@gmail.com

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ABSTRACT

The study's goal was to determine how animation techniques affected the academic performance of ninth-grade secondary school students in Multan. In addition to testing null hypotheses, three objectives and research questions were posed and addressed. The study used a non-randomized pretest-posttest quasi-experimental design. The population consisted of male ninth-grade chemistry students in the Multan Secondary School district during the 2021–2023 school years. Traditional methods were used in the class labeled as the control group, while the lectures in the class designated as the animation group were delivered using animation techniques through animated videos by LCD. Eighty-five (85) students from two complete classes were sampled. The Chemistry Achievement Test (CAT) is one of the instruments used to collect data. The research questions are answered using statistical tools such as percentages, mean ($\bar{x}$), and standard deviations. The research hypotheses were analysed using the independent sample t-test and the paired sample t-test. The study's conclusions showed that using animation as a teaching method could improve students' chemistry performance.

Introduction

Education, which spans many levels from early childhood to higher education and is marked by multiple developmental phases, is a process that assists people in gaining the information and skills necessary to design an organised, systematic curriculum based on their experiences (Yılmaz, 2021). In a world that is becoming more interconnected by the day, science and technology are continuously changing how people live and view the world. As a result, nations now place a high priority on hiring qualified and trained personnel and make investments in their training. These days, in what are often called the 21st century, more and more people are becoming knowledgeable about science and technology. Among the abilities listed are computer technology, multi-criteria decision-making, stress management, critical thinking, and introspective and creative thinking (Chikendu, 2018).

Additionally, it is often acknowledged by Bachtiar, Meulenbroeks, & Van Joolingen (2021) that instructional strategies including animation, simulation, digital technology-based training, and field trips to science centers are successful strategies that foster lifelong learning and demonstrate a high degree of information retention. Encouraging and facilitating the acquisition of knowledge and skills is the act of teaching. In the process, students interact with their instructors, learn new things, develop new skills, and generate creative ideas (Yustina, Syafii, & Vebrianto, 2020).

The education and training process is crucial for imparting enduring knowledge to students. There must be advanced cognitive abilities to enhance learning, enabling students to devise solutions and acquire knowledge through comprehension instead of rote memorization. A comprehensive science education is essential, prioritizing information retrieval abilities over simply delivering existing material (Maya & Saragih, 2021). Within this framework, scientific education employs diverse methodologies to enhance the understanding of various topics. The study utilized both technology-enhanced education, specifically computer animations, and traditional education methods, supplemented by PowerPoint presentations and relevant movies (Lowe, 2004).

Animations have a profound impact on teaching abstract concepts in science and technology courses. Demirkan (2019) suggest using animations to present scientific techniques. Integrating animations into teaching methods and procedures, while encouraging active student participation, ensures that a highly effective and efficient education is delivered. Information technology has facilitated the integration of computer technologies into educational settings. Advancements in computer technology enable educators to incorporate visuals, films, simulations, and animations with written texts into their teaching.

According to Llobera, & Charbonnier (2023), social studies, classroom instruction, mathematics instruction, physics instruction, biology instruction, science instruction, and chemistry instruction are all very important. Teaching science is more important in these occupations. Due to its transdisciplinary framework and ability to improve understanding, science education plays a vital role in people's comprehension of the society and environment in which they live (Yusa, Ardhana, Putra, & Pujaastawa, 2023). Though mostly teacher-centered, instructional methods are conventional approaches. According to Yilmaz (2020), kids mostly use memorisation and repetition in their passive learning. Both teacher-centered and student-centered approaches are used in contemporary teaching methods. Nonetheless, the instructor takes on a higher leadership role, offering guidance and assistance to the pupils (Jung & Brady, 2020). Some of the methods mentioned in the text include artificial intelligence, context-based learning, brain-based learning, out-of-school learning, game-based learning, mobile learning, animation, and simulation, teaching with analogies, and using mind maps (Yanarates, 2022; Usman & Madudili, 2020).

The 21st century is often referred to as the digital age or the era of digital applications. According to Burgess and Stevı & Haryanto (2020), technology has become as an essential aspect of our life and use it at all levels as a result of the amazing developments in information technologies, especially during the 2000s. Without a question, technology has permeated every aspect of our lives and profoundly influenced educational policy initiatives and processes. As such, the integration of technology-based solutions into this process has become essential ((Brasier, Melville, Hershock, & Rule, 2019). Using simulation and animation to carry out potentially dangerous laboratory experiments is very crucial in the scientific teaching process. There are several advantages to this method in terms of time, labour, and safety particularly in the domains of biology, chemistry, and physics. Many students will encounter chemistry, which is a subject that is universally intriguing in the context of its practical application in real-life circumstances (Stevı & Haryanto, 2020). Chemistry focuses on the exploitation of natural resources and the production of synthetic ones. Chemical science possesses the ability to establish a comprehensive system that facilitates the production and distribution of essential resources such as food, machinery, and materials, which are indispensable for contemporary living. Chemistry is a complex and abstract discipline that can be challenging to comprehend. The students need to visually image the essential ideas in order to comprehend the chemical phenomena (Saputra, Gürbüz, & Haryani, 2021).

García-Carmona (2020) suggested that interest is crucial in psychological and educational measurement, and chemistry education can be enhanced through suitable teaching methods and resources. Using multimedia techniques with animated information offers benefits like safety, auditory, visual, and multimedia elements, allowing continuous practice, experimentation, and critical thinking. Computer-assisted instruction (CAI) is a valuable tool for teachers to enhance education by presenting animated visuals to students, making them see them as real-life experiences. Students appreciate this method's opportunities, contextualization, and challenges. Visual elements like animations, graphics, and multimedia software play a significant role in technology-assisted teaching, impacting abstract subjects in science and technology courses. Advancements in computer technology have increased its use in educational settings (Cevahir, Özdemir, & Baturay, 2022).

Because computer cartoons show dynamic transitions through object movement, educators are increasingly using them as teaching tools. Beyond merely illustrating activities or fantastical scenarios, animations can enhance understanding of chemical principles and allow viewers to explore atoms and molecules (Yanarates, 2022). A more engaging educational experience results from the students facing fewer obstacles during the sessions (Cooper & Stowe, 2018). Students can access both spoken and visual resources through multimedia learning, such as static graphics and dynamic animations. Visual forms such as animations can help people understand pictorial chemistry, a field of universal interest in human development. Chemical science focuses on the use of natural and synthetic resources, which are critical for food, machinery, and materials. It can develop an infrastructure for these purposes (Çınar & Kurt, 2019).

One common way to show a sequence of images on a computer screen is through computer animations. According to Sailer, Schultz-Pernice, & Fischer (2021), the subject has three characteristics: the use of simulation, constructive acts, and visual representations. For animations to avoid distraction and achieve their intended aims, salience and briskness are crucial since they must match the context of the topic. Animations that employ briskness improve viewers' comprehension of the material as a whole (Deibl, Zumbach, & Fleischer, 2023). In order to enhance the effectiveness of learning, it is necessary to complement traditional teaching methods, such as blackboards, with animation coaching strategies. For more than two decades, animation has dominated technology-based learning environments (Egbutu & Okeke, 2021). Classrooms and educational television programs use instructional animation as a powerful tool to effectively convey knowledge to all age groups in an accessible and engaging manner. It has gained popularity as a creative, practical, and student-focused alternative to traditional learning methods, enhancing their ability to depict evolving ideas.

Rahayu, Treagust, & Chandrasegaran (2022) highlight the benefits of live movies and laptop animations in teaching and learning. Live movies offer accurate data and cognitive stimulation, leading to improved subjective coping. Laptop animations are beneficial for imparting technological information and raising environmental awareness. Technology-based classroom practices should be based on activities that students can cognitively digest. Animations can help students comprehend complex knowledge by integrating it into their cognitive framework. All age groups can use them and combine them with instructional methodologies for effective education. The proliferation of information technology trends has led to a greater adoption of laptop technologies in educational settings. It is recommended that medical questioning tactics be included in animations (Farrokhnia, Meulenbroeks, & Van Joolingen, 2020).

The process of creating the appearance of movement in images by capturing a series of drawings, models, or puppets is known as animation. It may be stop-motion, 2D, 3D, or traditional. Motion films with unique designs and computer-generated effects are energetic. For authenticity, the industry prefers 3-D animation. Education is the main way to give people the skills and knowledge they need, allowing for real-world experiences, exposure to role models, and practical participation (Çınar & Kurt, 2019). This study aims to ascertain how interactive computer simulation and animation affect high school chemistry students' motivation and level of satisfaction. Comparing the performance of students in experimental and control groups on assessments pertaining to particular chemistry concepts is the specific focus of the study. A small group of schoolchildren carried out the study.

Objectives of the Study

The study's objectives were to:

1. To examine the impact of Animated Technique of teaching on academic achievement of students in the subject of Chemistry at secondary level.
2. To assess secondary school students' academic achievement in the subject of chemistry.
3. To compare the Animation Technique and traditional method of teaching regarding academic achievement at the secondary level.

Research Hypothesis

The study's hypotheses were:

Hypothesis I

Ho: There is no significance difference between achievement scores of experimental group and the control group in pre-test.
H1: There is significance difference between achievement scores of experimental group and the control group in pre-test.

Hypothesis II

Ho: There is no significance difference between achievement scores of experimental group in pre-test and posttest.
H1: There is significance difference between achievement scores of experimental group in pre-test and posttest

Hypothesis III

Ho. There is no significant difference in the achievement scores of the control group and the experimental group in the post-test.
H1: There is a significant difference in the achievement scores of the control group and the experimental group in the post-test.

Hypothesis IV

Ho. There is no significant difference in the achievement scores of the control group and the control group in the post-test.
H1: There is a significant difference in the achievement scores of the control group and the control group in the post-test.

Hypothesis V

Ho. There is no significant effect of Animation Technique on Students Academic Achievement in Chemistry at Secondary Level.
H1: There is no significant effect of Animation Technique on Students Academic Achievement in Chemistry at Secondary Level.

Significance of Study

This study aimed to analyze the effect of the animation technique on students' academic achievement in chemistry at the secondary level. It may be helpful for teachers, students, head-teachers, and administrators in such a way that animation techniques may be more effective than traditional teaching methods in terms of enhancing students' achievement. Simple descriptions using words, diagrams, and figures are merely snapshots, but educators may make chemical reactions, molecular structures, and atomic interactions appear more interactive by showcasing and describing processes and changes in motion.

Making animated lecture materials may be essential since it enables students to store the information in their long-term memory, which facilitates retrieval at a later time. It is well known that animations appeal to multiple senses, which is important since it speeds up the processing of information and helps people remember it. Teaching with animation may encourage students to pay attention to the material and may remind them of the teachings on a regular basis. Because the content is not so intimidating as to turn off pupils, effective animations are known to enhance their impressions of classes and increase their willingness to participate. Conceptual learners, who learn best when there is a greater usage of imagery, are particularly drawn to animation. Thus, using animations, teachers provide for students with different learning styles and ensure effective implementation of the inclusive learning strategy.

Such schemes may be an excellent technique to provide the material so that students do not fall behind in the learning process if they are unable to have real-time exposure to well-equipped laboratories or competent lecturers. To learn as much as they want about a particular topic, students can pause, fast-forward, or rematch a sequence of cartoons. By raising students' awareness and comprehension, animation can greatly enhance their academic achievement in chemistry. Additionally, animated assessments and interactive quizzes can improve students' immediate performance by highlighting their mistakes. Implementing the idea of animation will make the students more innovative users of new technologies that are widely used not only in learning but also in other spheres of human life. Encouraging the adoption of technology in learning will increase innovation as well as creativity by learners and instructors

Research Methodology

This study employed a research design that was considered to be quasi-experimental. It is important to note that the study utilized a non-equivalent control-group design. One sort of experiment is known as a quasi-experiment, and it is characterized by the fact that it is not possible to randomly assign individuals to either the experimental or control groups. Researchers instead make use of groupings that are either intact or already in existence (Nworgu, 2015). There were two different streams of a class that the researcher labeled as the experimental group and the control group, respectively. This research design is considered appropriate because it did not randomly assign participants to groups. Instead, we randomly assigned the treatment condition to two pre-existing groups that remained intact. They selected the design to cause the least amount of disturbance to the instructional institution's lesson plans and classroom arrangements. A pure experimental design, which is known to disrupt school activities, may not always be viable, according to Nworgu, who stressed that a quasi-experimental research methodology is ideal for use in school settings. Classes were employed in their initial, unaltered state, where they were stored.

The study focused on Multan's School Education Department, specifically the local government areas of GHS Laber and GHS Jam Pur. Teachers at this location prioritize the delivery of high-quality education, making this study more effective. The recommendations derived from the study will be implemented due to the predominant presence of academicians residing in this area who possess a deep understanding of the significance of high-quality education.

Every high school in the Multan district at the study location follows the same chemistry curriculum because Pakistan uses a centralised national curriculum. Conveniently, the researcher chose one high school guy and divided him into two groups at random: the experimental group and the control group. There were 44 kids in the experimental group's school's pre-existing, entire ninth-grade section, and 41 pupils in the control group's school. As a result, the sample for the study was composed of 85 ninth-grade pupils. The experimental group was taught using the animation technique, whereas the control group was taught using the traditional approach.

Data Analysis

The purpose of the study was to determine the impact of animation techniques on secondary-level chemistry students' academic achievement at Govt. High School Laber Tehsil Multan Saddar and District Multan. The participants' demographic data is provided.

Table 1: Sample of the study

Grade	Subject	Age	Group	N	%age
9^{th}	Chemistry	14-17 year	Control	41	48.24
			Experiment	44	51.76
			Total	85	100

An analysis of the sample respondents' demographic data is shown in Table 6.1. Of the 85 students in the sample, we assigned 45 (51.76%) to the experimental group and 41 (48.24%) to the control group. These 85 students had an average age of 15.5 years. The sample students' age range spanned from 14 to 17 years. The independent sample t-test showed that there were no significant variations in the ages of the students in both groups. Therefore, we assumed that the demographic composition of the two groups was similar.

Table 2: Independent sample t-test with respect to pretest for experimental and control groups

Groups	N	Mean	SD	T	Df	Sig
Experimental	44	17.682	4.263	-1.032	83	0.242
Control	41	16.634	5.029	-1.038		

Table 2 displays the results of an independent-sample t-test that was used to evaluate the mean scores of the experimental and control groups in relation to the pretest. Additionally, Table 6.2 showed that the overall mean score of the experimental and control groups, respectively, compared to the pretest, had a p value of 0.242. It stated that the control group's mean was 16.634 while the experimental group's was 17.682. Furthermore, the mean value suggested that both groups appeared almost equal and were regularly distributed. According to Table 6.2, the null hypothesis was accepted since the two groups' academic performance was nearly identical and their p-value was 0.242, which was higher than 0.05 overall in the pretest. So, there is no significance difference between achievement scores of experimental group and the control group in pre-test (Null hypothesis of hypothesis 1 is accepted).

Table 3: Independent sample t-test for experimental and control group with respect to posttest.

Groups	N	Mean	SD	T	Df	Sig
Experimental	44	34.409	10.429	-6.175	83	.003
Control	41	22.780	6.639	-6.082		

The overall posttest mean scores of the experimental and control groups were compared using an independent-samples t-test, the results of which are shown in Table 6.3.It provides additional evidence that the p values for the experimental and control groups' is 0.003 which is smaller than the significant value 0.05. Experimental mean score 34.409 is greater than the mean score of control group mean score 22.780. Since the p-value of.003 is smaller than the significant value of 0.05, the null hypothesis is rejected. Thus, it has been demonstrated that the pretest and posttest differ significantly (Alternative hypothesis of hypothesis 3 is accepted).

Table 4: Paired sample t-test for experimental group with respect to pretest and posttest for overall performance

Groups	N	Mean	SD	T	Df	Sig
Pretest (Experimental)	44	17.682	4.263	-15.461	43	.000
Posttest (Experimental)	44	34.409	10.429			

To find the significant difference between the mean total score of the experiment's group on the pretest and posttest, a paired-samples t-test was utilised (Table 4). The pretest group (M=17.682, SD=4.263) and the post-experiment group (M=34.409, SD=10.429) exhibited substantially different scores with the standardised value of p set at 0.05. These results show that after treatment, pupils' chemistry academic performance improved. In particular, our results showed that the experimental group's performance much improved when they received treatment, such as animation techniques. Additionally, Table 6.4 demonstrates that the p value was less than the specified threshold of 0.05, at.000. Thus, the null hypothesis is disproved of Hypothesis 2.

Table 5: Paired sample t-test for control group with respect to pretest and posttest for overallperformance

Groups	N	Mean	SD	T	Df	Sig
Pretest(Control)	41	16.634	5.029	-13.135	40	.000
Posttest (Control)	41	22.780	6.639			

Paired-samples t-test was used to compare the significant difference between the control group's overall mean score on the pretest and posttest (Table 5). Mean scores of the post-control group (M=2.780, SD=6.639) and the pretest control group (M=16.634, SD=5.029) differed only slightly. Furthermore, Table 6.5 revealed that the assigned value of 0.005 was greater than the value of p=0.000. It is determined that the null hypothesis is rejected in of hypothesis 4

Conclusions

The results of the study show that using animation as a chemistry teaching method significantly raises secondary students' academic achievement. Three specific findings were reached by the study in order to address the research hypotheses: 1) Prior to the experiment starting, the control group and the experimental group's average chemical accomplishment scores did not differ significantly. This result implies that before the intervention, children in both groups had comparable academic proficiency. 2) In addition, the study's results show a significant difference in the experimental group's average chemical performance scores before and after the test. The results indicate that secondary-level pupils' performance in chemistry was significantly impacted by the animation technique and 3) There was a substantial difference between the two groups' post-test mean chemistry accomplishment scores. According to this finding, the animation method considerably raises secondary school pupils' proficiency in chemistry.

Discussion

Computer animation as opposed to more conventional forms of communication, raises students' academic achievement in the field of chemistry was one of the main objectives of this study. Higher levels of academic accomplishment in chemistry have been linked to instructional computer animation, according to research. Compared to students taught using conventional methods, those taught utilising computer animation received higher average scores.

The findings of this study are corroborated by a prior study by Yanarates (2022), which shown that animation significantly improves chemistry students' academic performance when compared to traditional teaching methods. One way that computer animation is different is that it allows students to participate in active learning through interaction. This conclusion was further supported by Mekonnen, Yehualaw, Mengistie, & Mersha (2024), which offered proof that instructional animations improve students' learning. Ercan, Bilen, & Bulut (2014) discovered a significant difference in the students' academic performance favoring the experimental group. It was found that students who learnt chemical bonding through animation performed significantly worse academically than students who learnt it the old-fashioned manner.

Students' increased level of involvement is directly responsible for the experimental group's claimed improved academic advancement. The results of the study indicate that the two groups' average post-exam chemical accomplishment scores differed significantly. According to this research, high school pupils' academic performance in the subject of chemistry is significantly impacted by the usage of animation technology. Animation does not raise pupils' attention levels, according to the findings of earlier academics by Archambault, Leary & Rice (2022)**.** However, he discovered that it improved pupils' academic performance.

The findings are consistent with those of Cooper & Stowe (2018), who also tested the particle form of matter and discovered that animation improved conceptual understanding. The findings of Akpoghol, Ezeudu, Adzape, & Otor (2016), however, run counter to this finding. They discovered that students who received electrochemistry teaching using a lecture method with music performed better on tests than those who received instruction through animation. Gongden, John, & Gongden (2020) looked into how animation affected the academic performance and self-esteem of secondary school pupils with different cognitive types (formal and concrete) in chemistry. The results show that animation can be a useful teaching tool for chemistry, particularly for subjects that include particle movement, such as chemical bonding, the particulate foundation of matter, and electrolysis. Both abstract and practical chemistry students may benefit from it in terms of their academic performance.

Recommendations

In the end, this study recommends that curricula at teacher training facilities and teacher education programs adopt an animation approach. The ability, expertise, and competency of teachers in their specialised fields of instruction could all be improved by this integration. This study offers significant insights for educators, school administrators, and policymakers to enhance the academic achievement of chemistry students. The inquiry's results and conclusion suggest that teachers incorporate animations into their chemistry lessons to improve the subject matter's teaching. Conferences and seminars on animation pedagogy The research proposed the recommendations:

1. The teachers should to employ the animation style when delivering lessons on chemistry.
2. The teachers should use animation. The administration should encourage the use of animation techniques for education.
3. Teachers in schools should have a well-structured strategy and receive training on the animation approach to enhance academic achievement in chemistry.
4. Future researchers should carry out a comparable study that focuses exclusively on private schools in order to direct future studies.
5. In subsequent research, this study should be used as a model for assessing different teaching approaches.
   5. It is suggested that the chemistry curriculum be taught via instructional computer

animation in all public secondary schools. Students will become more interested in learning the subject as a result.

6. Professional organizations should host conferences, seminars, and workshops to inform working teachers who are unfamiliar with instructional computer animation and its benefits.

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