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EFFECT OF COMPUTER ANIMATION TECHNIQUES ON SECONDARY SCHOOL STUDENTS' INTEREST, ACHIEVEMENT AND RETENTION IN ORGANIC CHEMISTRY IN ZONE A, BENUE STATE, NIGERIA

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ABSTRACT

The study investigated the effect of Computer Animation Techniques on Secondary School Students' Interest, Achievement and Retention in Organic Chemistry in Zone A Area of Benue State, Nigeria. Quasi-experimental research design was adopted. The population of the study consisted of 3041 (1573 males and 1468 females) senior secondary two (SS 2) students from 85 co-educational public secondary schools across the seven local government areas in Education Zone A, Benue State. A sample of 361 (180 males and 181 females) SS 2 students from 6 co-educational public senior secondary schools in six local government areas in Education Zone A, Benue State was selected using a multistage sampling technique. Organic Chemistry Interest Rating Scale (OCIRS), Organic Chemistry Achievement Test (OCAT) and Organic Chemistry Retention Test (OCRT) were used for data collection. Mean and standard deviation were used to answer the research questions while Analysis of Covariance (ANCOVA) was used to test the null hypotheses at 0.05 level of significance. The findings were as follow: computer animation techniques significantly enhanced students' interest compared to conventional method ($P = 0.000 < 0.05$). Computer animation techniques significantly enhanced students' achievement in Organic Chemistry more than the conventional method ($P = 0.000 < 0.05$). Students taught Organic Chemistry using computer

animation techniques have higher retention scores than those taught using conventional method($P = 0.000 < 0.05$). Male students had higher interest and achievement scores than the female students when taught Organic Chemistry using computer animation techniques ($P = 0.000 < 0.05$). Male and female students had the same level of retention ability when taught Organic Chemistry using computer animation techniques ($P = 0.986 > 0.05$).The study concludes that despite the significant interaction effect of gender and computer animation techniques on students' interest and achievement, the strategy plays crucial roles in enhancing students' interest, achievement and retention in Organic Chemistry. Based on the findings of this study, it was recommended among others that computer animation instructional techniques should be given serious consideration by Chemistry teachers because of its proven positive effect on students' interest, academic achievement and retention in Chemistry.

INTRODUCTION

Science and technology education is a driving force for the development of any nation. It is the pivot on which the wheel of scientific and technological development rotates. Science has been seen as an organized system of explanations of nature through the process of experimentation (Gongden, John & Gimba, 2019). Such experimentations may be modified based on light shed by further empirical evidences by the practitioners of science. Therefore, science could be seen as man's attempts to investigate, explore, interpret and operate with the materials and the forces of universe that surround him.Computer animation is a product of modern technologies that involves the use of computer-generated graphics to produce moving images. Computer animation produces special effects and stimulates images that would be impossible to show with non-animation techniques. Prior to the advent of computer, animation was achieved by filming hand-drawn or painted sequences on plastics or papers. Animation means liveliness as it involves objects and things in humorous motion. In Organic Chemistry, computer animation can be used to visualize the reactions, structure and arrangement of atoms within a molecule since some of these reactions cannot be seen with the naked eyes in the laboratory. Considering the benefits that computer animation techniques seem to present, there is need for teachers who are professionally well trained, to use more effective and scientifically aligned strategies such as animation instructional techniques to teach senior secondary students offering Chemistry the key concepts and principles or else students will not assimilate the concepts or principles (Gongden, Yame & Gongden, 2020).

Statement of the Problem

Chemistry provides students with the knowledge of scientific principles that explain natural phenomena. It develops critical thinking, problem solving, and practical skills that are essential for innovation and everyday life. Additionally, it fosters technological literacy, enabling students to apply scientific knowledge to improve living standards and contribute to national development. In view of the above, it is expected that teachers should employ effective instructional strategy that stimulate interest and enhance better achievement.

However, it has been observed by the researcher as a Chemistry teacher that many students show low interest when it comes to learning Chemistry. The persistent fluctuations in students' academic achievement in Chemistry over the years as evident in students' results in West African Examination Council from 2019-2024 have been a source of worry to researchers, science educators, parents and even the students themselves. One may suspect the unsatisfactory academic achievement in Chemistry to be attributable to adopting conventional teaching approach (talk-chalk method) of instructions like lecture method, project method and discovery methods which are often employed by the teachers despite its been teacher-centered.

The implication of students' low achievement and fluctuation in academic achievement in Chemistry is that there will be low enrollment of students in Chemistry related courses. The effect of this is low manpower to cater for the scientific and technological needs of the nation. In addition, conventional method of teaching limits the room for learners' active participation in the instructional process, seldom takes into account individual differences makes students uninterested in class, discouraged and bored. Thus, researchers have continued to seek better ways of teaching using different methods and strategies, yet their efforts have not yielded the much-desired result. Therefore, students' persistent fluctuations in academic achievement as evident between 2019 and 2024 (See Appendix A) needs to be addressed urgently by employing appropriate techniques among other measures. One major challenge facing Chemistry teachers is their inability to explore and adopt new innovative teaching strategies that will be attractive to student which will not only draw students to learning and understanding Organic Chemistry concepts but also enhance their achievement and retention of concepts in the subject. There is, therefore, a need for secondary school teachers to embrace innovative technology teaching strategies like the computer animation techniques in the classroom practice that could help improves the understanding of abstract concepts in Chemistry. The application of ineffective teaching strategies by teachers has been a major challenge in the teaching and learning of Chemistry. It therefore has become necessary for the

researcher to investigate the effect of computer animation techniques on secondary school students' interest, achievement and retention in Organic Chemistry in Zone A area of Benue State, Nigeria.

OBJECTIVES

The objective of the study is to determine the effect of computer animation techniques on students' interest, achievement and retention in Organic Chemistry. Specifically, the study is designed to:

1. determine the effect of computer animation techniques on students' interest in Organic Chemistry.
2. to determine the effect of computer animation techniques on male and female students' interest in Organic Chemistry.

Research Questions

The following research questions guided the study.

1. What is the difference in the mean interest ratings of students taught Organic Chemistry using computer animation techniques and those taught using conventional method?
2. What is the difference in the mean interest ratings of male and female students taught Organic Chemistry using computer animation techniques?

Hypotheses

The following null hypotheses were formulated and were tested tested at 0.05 level of significance:

There is no significant difference in the mean interest ratings of students taught Organic Chemistry using computer animation techniques and those taught using conventional method.

There is no significant difference between male and female students' mean interest in Organic Chemistry when taught using computer animation.

Significance of the Study

The study may be beneficial to students, teachers, curriculum planners and the society at large.

The findings of the study would enable secondary school students to expel some of the phobia they have in learning organic Chemistry. Chemistry students will realize that their achievement depends to a great extent on their own active participation in the class. Students

will begin to appreciate their involvement in class activities which will help gain some lasting skill and interest that will enhance retention and academic achievement.

The findings of this study will help Chemistry teachers to properly implement the Chemistry curriculum. The advantages of use of computer animation in learning Chemistry in the classroom will motivate the teachers to teach the subject well. The strategy would help the teachers to find an easy way of presenting difficult concepts, thus arousing the interest and active participation of the student as well as improving retention level.

The curriculum planners would gain a better insight on how to implement some difficult concepts in Chemistry by incorporating computer animation techniques to make the subject activity oriented and student-centered so as to arouse the interest of students in the subject and enhance academic achievement. The study will provide valuable insights that can guide educators in designing effective instructional materials and strategies that harness technology to improve learning outcomes.

The general public will also gain from the findings of the study. If Computer Animation Techniques adequately improves students' academic achievement, interest and retention of concepts in Chemistry, the subject and its related courses will gain attention by the students in senior secondary school thus, achieving the nation's dream of capacity building and sustainable development.

Theoretical Framework

The theories that support this study are Paivio's Dual Coding theory (1965), Ausubel's Meaningful Learning and Sub-Sumption theory (1963), and Multimedia Learning Theory by Richard Mayer, (2001)

Dual Coding Theory by Allan Paivio (1965)

Dual coding theory, a theory of cognition was hypothesized by Allan Paivio in 1965. The theory states that a person expands in knowledge through verbal association and visual imagery. Dual coding theory postulates that both visual and verbal information are used to represent information. The theory is talking of knowledge through imagery and pictures with verbal explanatory verses accompanying the pictures.The Dual Coding Theory emphasizes that pictures make the acquisition of knowledge easy especially when it is accompanied with explanation. It urges teachers to allow students to have direct experience with things and that both words and picture must be presented to the intellect at the same time. The verbal system is important in learning but not enough because verbal system gains knowledge from the non-verbal system; verbal system may be good at one task and non-verbal system better in the

other. Both the verbal and non-verbal codes are functionally dependent of the other and can have additive effect on recall of knowledge.

The implication of the theory to this current study is that it aligns with the use of computer animation techniques in teaching Organic Chemistry by combining visual and verbal elements to improve students' interest, achievement and retention.

Meaningful Learning and Sub-Sumption Theory by David Paul Ausubel (1963)

Meaningful learning and Sub-Sumption theory was propounded by David Paul Ausubel in 1963. The theory states that an individual existing cognitive structure is the principal and basic factor influencing the learning and retention of meaningful materials. It describes the importance of relating new ideas to a student existing knowledge base before the new material is presented. The new knowledge will be subsumed into the learners existing cognitive structure. When information is subsumed unto what the learner had already known, it will be transferred into the long-term memory.Ausubel propounded this theory alongside what he called advanced organizer. Advanced organizer is a preview of the information to be learned. The teacher does this by providing a brief introduction in the way the new information will be presented. The advanced organizer enables the student to start with a good picture of the upcoming content and links new ideas to the existing mental maps of the content area. Therefore, difficult concepts like the Organic Chemistry with its' abstract nature is difficult for students to understand. The students do not have any alternative than to adhere to rote memorization which do not give them the in-depth knowledge of what they learned and this is what Ausubel's theory opposes.

The implication of this theory to this study is that using computer animation techniques to teach involves putting Chemistry abstract concepts and ideas into motion pictures as though these pictures are life and active which will interest students and make them see them as real objects. As the teacher explains the animated objects as they sequentially come up, the subject matter becomes simple to understand because the new knowledge will easily be subsumed into the old cognitive structure of the learners making retention and retrieval easy. The role of computer animation is to make learning meaningful, interesting and retentive.

Conceptual framework

Computer animation

Computer animation is the use of graphics, text, video, sound and images in instructional process. Bamidele and Yoade (2017) defined computer animation as simulated motion pictures showing movement of drawn objects. Bamidele and Yoade added that it seeks to

arouse students' interests, stimulates thinking and concretizes knowledge that could otherwise only be explained in abstract term. In the conceptualization of Chiakwelu (2021), computer animation in teaching is the use of text, graphics, motion picture, background sound as well as some narrations in instructional delivery. This implies that computer animation has the features of both audio and visual presentations.

The use of animated materials reduces the learning task and time; it creates room for consistency and learning mastery by increasing retention, safety and motivation (Chiakwelu, 2021). The authors added that it facilitates communication and appeals to senses of sight and hearing which makes learning more meaningful and permanent. In the same vein, Rashid, Khanum and Khan (2024) posited that multimedia computer animation seems to attract students' attention and increase their motivation to learn. It could be deduced from the above that the use of multimedia computer animation could increase students' motivation and make the learning of chemistry more interesting, enjoyable and understandable.

Computer animation has been traditionally defined as inanimate entities that appear to take on dynamic attributes such as motion and growth which are normally associated with living organisms (Anih & Obadiaru, 2024). Computer animation is the process of creating moving images using computer graphics. It involves generating animated sequences by manipulating digital models and environments to simulate motion and dynamics. Basak, Yucehan and Ahmet (2018), described computer animation as an effective learning tool that attracts attention, engages learner, and sustains interest and enhance retention of concepts that results in meaningful learning. According to Chinelo and Okafor (2023), computer animations involve animating graphics in specific scenarios and should be seen as alternative methods for visualizing knowledge. However, Arumugam, Suppiah, Manap and Munchar (2022) pointed out that the use of computer animation in classrooms aims to engage students' interest, motivate them to learn, and foster independent responsibility for education, higher-order thinking skills, and creativity in problem-solving.

Additionally, well-designed computer animations can facilitate faster and easier learning for students and serve as valuable tools for teachers in explaining difficult concepts. It has been shown from several research reports including Kasali (2015) and Nwoye, Obi, Ene, and Shiaki (2019) that animations as technological tools used in education have contributed a lot to the students' fulfillment of cognitive function. Nwoye, Obi, Ene, and Shiaki (2019) argued that the failure of teachers to implement suitable teaching strategies significantly impacts students' academic achievement in science and science related subjects. They suggested that the choice of instructional methods plays a crucial role in determining how effectively

students grasp scientific concepts and apply them. In technology-aided education, visual materials such as animations, animated pictures and multimedia software have a great importance. Use of computer animations and simulations has a significant effect in teaching difficult concepts of science and technology courses (Odey, 2025). Therefore, when teachers fail to select and use appropriate strategies that can aligned with the subject matter and students' learning needs, it can lead to lower academic achievement, interest and retention especially in science subjects.

Interest

Interest according to Okoro in Ndudi and Chinedu (2016) refers to things, a person likes or dislikes. It is the act of showing favourable curiosity or concern about somebody or something. Students' interest in the learning tasks determines their learning styles and cognition which in turn determine students mean terminal cognitive achievement. Interest is an effective learning which has to do with feelings and values and these influence our behaviour in one way or the other (Herpratiwi & Tohir, 2022). Friskila (2023) submitted that interest can be seen as the feeling one has in the course of wanting to know or learn more about somebody or something. Interest is therefore an activity or object that can be sustained depending on whether the individual whose interest is engaged stand to gain or lose by doing so. Interest is also said to be a combination between cognitive and affective process, which is based on positive emotion, personal values and possess owned knowledge that are in line with the subject interest (Tin, 2016).

Interest is a cognitive and affective motivational variable (Renninger & Bachrach, 2015). It is a sustained characteristic resulting in increased engagement and learning of students is regarded as a key that pushes students into a subject matter and inspires them to develop meaningful connections to a field of study (Harackiewicz, Smith & Priniski, 2016). In general, interest often refers to positive feelings and leads to an attraction, a preference and a passion. When students experience interest, they engage in intrinsic motivational behaviors and they can be propelled by enjoyment but not by extrinsic motivations (Siklander, Kangas, Ruhalahti & Korva, 2017). Interest refers to the inclination of the student towards a particular subject in which he or she is easily able to connect without any hassle or hurdle (Harackiewicz, Smith & Priniski, 2016).The interest relationship between person and object and interest development can be illustrated specifically with the following four-phase model of interest introduced by Hidi and Renninger (2016). The four phases are: triggered situational interest, maintained, situational interest, emerging individual interest, and well-

developed individual interest, with profound educational significance in current in-school and out- of-school learning.

When students are interested in a subject, they are more likely to go to class, pay attention, become engaged, take more courses as well as process information effectively and ultimately achieve well. Interest is a subjective feeling of intentness or curiosity over something and the interest in a particular thing is a feeling manifested in an activity or a tendency to become absorbed in an experience and to continue it (Owora & Chika, 2019). The authors added that, it is the zeal or willingness to participate in any activity from which one derives some pleasure. Interest is both a psychological state of attention and feeling toward a particular object or topic and an enduring predisposition to reengage over time (Renninger & Hidi, 2016). Interest is a powerful source of human motivational process that energizes learning, guides academic and career courses which is capable of arousing and sustaining concentrated effort that is essential to academic success (Owora & Chika, 2019). This interest can be achieved through application of effective teaching strategies and learning in the classroom.

Triggered situational interest is a forerunner for further development of interest. Triggered situational interest can be aroused by environmental elements and contents of learning; meanwhile, maintained situational interest can be pursued by significant tasks or personal participation. Both phases of situational interest can be triggered by instructional learning environments that supply meaningful activities, including collaborative group work, one-to-one tutoring. However, it should be noted that situational interest may not always facilitate further development of interest and sometimes has a negative influence. However, once situational interest is maintained, repeated engagement can be propelled by the environment and lead to the development of an emerging, and then a well-developed, individual interest (Hidi & Renninger, 2016). The characteristics of individual interest are positive feeling, stored knowledge, and task value.

With emerging individual interest, the student would like to value the task, generate her or his questions, redefine task demands, anticipate succeeding steps and bring effort. Compared with emerging individual interest, well-developed individual interest involves more stored knowledge and task value for contents. With well-developed individual interest, the student values and engages in the task again so that she/he can relate and try to find answers to questions. She/he is likely to employ various strategies and provide effort if it is required (Uyun, Bahriah & Sudirman, 2022). Both phases of individual interest need external support and encouragement from experts, teachers, and peers to increase task understanding and opportunity. Additionally, instructional situations and comfortable learning environments are

beneficial to develop and deepen those two phases of individual interest for knowledge building and achievement (Siklander *et al*., 2017).

It is clear that interest in the classroom may improve not only students' intrinsic motivational levels but can also stimulate their learning performance and engagement (Renninger & Bachrach, 2015). Meanwhile, triggers can profoundly change and influence students' interest in either a positive or negative direction (Uyun, Bahriah & Sudirman, 2022). Research has shown that interest-triggered learning activities can develop deep learning and engagement and lead to better learning achievement as well. Therefore, determining how to trigger students' interest is regarded as one of the most significant elements in learning and development (Brauer, Siklander & Ruhalahti, 2017). Technology acceptance includes perceived ease of use, perceived usefulness, self-efficacy, and enjoyment and is also an important factor in motivating students' interest in learning. Perceived ease of use has a positive influence on students' attitudes toward using technology It can trigger students' learning interest, provide chances for self- learning, and supply feedback and solutions for problems immediately (Bere & Rambe, 2016).

Salisu and Samuel (2025) reported that the poor academic achievement in science is caused by lack of laboratory materials, poor teaching method and strategies which resulted in lack of interest. Lack of interest in some subject is because the concepts are complex and the explanation is always abstract like in the case of Chemistry. As a result, students find it difficult to understand the concepts. To understand and retain concepts, students must be made to be interested in the concept. Science teaching in Nigeria secondary school is dominated by teacher-centred methods (Conventional method) which have been found to be ineffective when capturing students' interest (Salisu & Samuel, 2025). Okeke (2017) also discovered that no significant differences existed in the mean interest rating scores of male and female students. Uche, Okpala, Ebele and Okigbo (2021) reported that male students had a slightly higher mean interest gain than their female counterpart. For students to have interest in class activities, appropriate teaching strategy like computer animation techniques should be put in place so as to develop and enhance educational success, because students learn better in the subjects they have interest in.

The major determinant of students' interest in the learning task on any subject matter is the existing instructional system or teaching methods adopted by teaches especially in science-based subjects. Traditional teaching methods are teacher centered and therefore do not involve the active participation of the learners in the teaching learning process thereby retarding students' interest. Teachers should endeavor to use good innovative methods that

will stimulate students' interest in their attempt to make the learning of Chemistry more meaningful to learners. Interest is the key to educational success because learners learn better in subjects, they have some interest. Generally, if one has interest in something, one will want to learn or hear more about it and will take pleasure in doing it (Schumacher, Kammerer, Scharinger & Gottschling, 2024). Rone, Guao, Jariol Jr and Acedillo (2023) blamed the lack of students' interest in science including Chemistry on poor teaching method employed by most teachers. The curiosity and interest of students according to Mallik, Scholar and Yadav (2025) manifest in their academic achievement. The authors repeated that students whose interest had not been developed do not have the zeal to attend classes regularly. Even when they attend classes, they do not listen attentively either do they do their class work because they do not have interest in learning the subject being presented to them.

Schumacher, Kammerer, Scharinger and Gottschling (2024) provide evidence that many students tend to lose interest in science over the course of time. Though all subjects suffer from a steady decline in interest, only science and mathematics remained in decline when the intrinsic worth is considered. This being the case, it is very necessary for Nigerian science educationists to device ways of developing and sustaining students' interest in Chemistry. Interest holds much power as it helps students in connecting to their desired subjects, when students are connected with their subject of interest, engagement becomes effective and it deepens as they are seen investing more time and effort in learning as well as finding out ways of understanding and digging deep into the content and coming out with ideas in a meaningful way.

Retention

Retention is the process by which long-term memory preserves learning so that it can be located, identified and retrieved accurately in the future (Akpan, Notar & Beard, 2019). Retention is the process of transferring new information into long-term memory. This means the learners has effectively taken in the information and are able to recall it in the future. Without retaining what is learned, it will easily leave the short-term memory after a certain amount of time has passed. In order to improve students' learning retention, it is necessary to find new strategies and solutions to ensure that students are engage with the material (Haqie, 2021). Retention is a person's ability to transfer new information into their long-term memory so that it is easy for them to recall and put that knowledge to use in the future. In simpler words, learning retention is all about making new knowledge stick for a long time (Gupta, 2022).

Retention is the ability to store and retrieve correctly the ideas, facts or concepts learnt. It is the major determinant of students' academic achievement. Retention as a term is used to describe the remembering of a fact or idea after a passage of time (Baic, Oljaca & Tasic, 2021). It is only by demonstration of such retention that learning could be judged to have taken place. Meaningful learning is deemed to have taken place if after a passage of time; students can recall and apply information which he or she had been taught previously. There is growing realization that poor learning and retention of science concepts may be related to inability of students to understand and comprehend the medium of instruction used by teachers in the classroom. Retention level of a student refers to the idea or facts he or she has in his or her memory after he or she has been exposed to some learning experiences (Igbojinwaekwu & Dorgu, 2015). The authors further stress that the extent of attainment of the objectives of a particular learning experience by students is usually ascertained by finding a positive difference between the students' pretest and posttest scores. The retention level of students is therefore obtained by subtracting students' delayed posttest score from the posttest score. The positive retention means there is retention of subject matter of facts, while negative retention implies loss of facts after a specified period, for example, a week or a month exposure to the learning experiences.

Retention of scientific concepts according to Khishfe (2015) is defined as the proportion of knowledge retained by students after a specific retention interval. Its interval is the time that elapses between a test of original learning and that of a retention test. However, in the present-day school, it is common for students to learn material, take a test and forget the material soon after. Retention of difficult concepts in Chemistry is therefore, the ability and extent to which students can retrieve the concepts, symbols, equations or instructions from long term memory in the subject. The reasons why most students may not be able to retain Chemistry concepts may include the fear and the resultant stress which can lead to interference thereby making students to forget what they were taught, the language of instructional medium used in teaching science concepts and the one used in tests or examinations (Ngbea, 2016). Retention is the ability of the student to recall what is taught after a given period of time (Nwanze, 2016). Valderama and Oligo (2021) described retention as the ability to store and remember things experienced or learned by an individual at a later time. The author believed, when there is interference among learned material; speed and efficiency of learning is often decreased. Whereas anything that aids learning should improve retention.

Retention is the ability to retain and later remember information or knowledge gained after committing it into memory or it is the ability to store what has been learnt and recall what has been stored in the memory (Olarewaju, 2017). It encourages the ability of the student to apply knowledge from lessons in particular situations as a function of recall and conceptualization (Oyovwi & Emmanuel, 2022). Students' retention is affected by a number of factors including instructional techniques, interest, student's activity during lesson, lesson assignment, exercises (Miles, 2015). The level of retention is mostly determined by the teaching strategy used in teaching and learning concept and the nature of the materials to be coded also contributes to the level of retention (Ugwu, Jatau & Gwamna, 2020). In this regard, Michael, Joseph and Iornyagh (2020) stated that anything that aids learning in school will eventually improve retention. If what is learnt in the classroom is retained over a long period of time, student achievement in classroom exercises and examination may improve.

Gender

Today, equality between boys and girls has become a major scourge plaguing the world, particularly in developing countries, and also in the exact sciences such as Mathematics, Physics and Chemistry which is due to the general development of science. Societal stereotyping and gender inequalities create significant barriers that discourage girls from pursuing science careers. (Christie, O'Neill, Rutter & Young, 2017). Gender refers to the roles and relationships between men and women in a given context (Matsani, 2022). Gender imbalance is conceived as the structural relationship of inequality between males and females as manifested in education. Gender is considered as a variable that can have much effect on both teachers and students in the teaching and learning processes. Gender according to Oyibe (2016) is a psychological experience of being a male or female. It has to do with personality and central components of self-concept. Unlike sex, which is concerned with, only the distinction between male and female based on biological characteristics, gender encompasses other personality attributes as roles, orientation and identity based on individual's conceptualization of self.

Nnamani and Oyibe (2016) opine that gender refers to a socio-cultural construct that connotes the differentiated roles and responsibilities of men and women in a particular society. This definition implies that gender determines the role, which one plays in relation to general political, cultural, social and economic system of the society. Sex refers to a set of biological attributes in humans and animals. It is primarily associated with physical and physiological features including chromosomes, gene expression, hormone levels and function, and reproductive/sexual anatomy. Sex is usually categorized as female or male but

there is variation in the biological attributes that comprise sex and how those attributes are expressed. Gender refers to the socially constructed roles, behaviours, expressions and identities of girls, women, boys, men, and gender diverse people (The Canadian Institutes of Health Research, 2023). It influences how people perceive themselves and each other, how they act and interact, and the distribution of power and resources in society. Gender identity is not confined to a binary (girl/woman, boy/man) nor is it static; it exists along a continuum and can change over time. There is considerable diversity in how individuals and groups understand, experience and express gender through the roles they take on, the expectations placed on them, relations with others and the complex ways that gender is institutionalized in society (The Canadian Institutes of Health Research, 2023).

Gender issues in the context of education is referred to as the differences, both real and perceived between boys and girls and their relative achievements and opportunities (Mankumari & Ajay, 2017). There are studies on gender gaps in students' learning attitude, but these results are inconsistent. It has been reported that boys' divergent thinking ability, which is related to creativity, is significantly better than girls' and increases with grade (Jia, Yang, Qian & Wu, 2020). However, Castillo-Vergara, Borrios, Galleguillos, Jofre, Alvarez, Marin and Acuna (2018) found females exhibited higher results than males in creativity's three-dimension, fluency, flexibility and originality. Okolo (2018) asserted that gender issues have a source of aversion and that Science related subjects has been male stereotyped since it was regarded as abstract and difficult subject as well as has attributes which boys were attracted to. Ani, Kalu, Iketaku and Obodo (2020) in the study conducted, observed that male students performed better than their female. Godpower-Echeand Owo (2019) reported a positive correlation between gender and students' achievement.

Gender has impact on the academic achievement of students in science education. Dawal (2021) opined that Science and Technology is a male dominated subject and that females tend to shy away from scientific and technological fields and that those that have ventured into it achieved less than their male counterparts. Theses researchers concluded that males therefore, appear to have a natural positive attitude to science and technological subjects and as such achieve better, while females show negative attitude and therefore achieve less. This negative attitude and presumptions that male students achieved better than female students in science and technology subjects appears to be due to the acceptance of the myth that males are better in the subject than females.

A number of studies (Amogne, 2015; Godpower-Eche&Owo, 2019; Jia, Yang, Qian & Wu, 2020) have been carried out on gender issues relating to academic achievement in many

school subjects at all levels of education in different countries with different results reported. With regard to gender gap in science achievement, the finding is somewhat divided with some researchers reporting no significant difference between male and female students' academic achievement while others found statistically significant difference between male and female academic achievement in favour of the male students. Yet, other studies showed the significant difference in favour of girls. A study conducted by Bhutta, Ansari and Ahmad (2024), result shows that girls had higher science scores than boys in all grade levels. It was reported that the difference in science achievement score between boys and girls was not significant, while a statistically significant difference in favour of girls exist in the 8th grade. Umar, Lameed and Ayodel (2022) found no significant difference in the achievement of male and female students and observed that male and female students achieved almost equally when exposed to innovative teaching strategy.

Godpower-Echie and Ihenko (2017) reported no significant influence in academic achievement of male and female students in basic science. Moreover, Ajayi and Ogbeba (2017) reported that there is no significant difference between male and female students taught stoichiometry using hands-on activities. The influence of gender on achievement and in science education is therefore still a controversial issue among science researchers. These contradictive evidences in academic achievement and lack of clear trends on gender influence in the study of science have resulted in the need to carry out a study with a view to determine the effect of computer animation strategy on students' interest achievement and retention in Organic Chemistry.

Review of Related Empirical Studies

Nwotolo, Nwafor, Okpube, Enyi, Nwovu, and Ikporo (2025) investigated the effect of Animation Instructional Strategy on Senior Secondary School Students' Achievement and Retention in Biology in Abakaliki Education Zone of Ebonyi State. Six research questions and six hypotheses guided the study. A quasi-experiment pre-test, post-test non-equivalence control group research design was adopted for the study. Senior secondary two (SS 2) students from all the 85 public secondary schools in Abakaliki Education Zone numbering 11,758 formed the population of this study. The sample of the study comprised 468 students of the intact classes of four randomly sampled schools from the four local government areas in the zone. Biology Achievement Test (BAT) with reliability coefficients of 0.79 (for internal consistency) and 0.89 (for stability) were used as instruments for data collection of this study. Mean and standard deviation were used to answer the research questions while analysis of

covariance (ANCOVA) was used to test the hypotheses at 95% confidence level. The results revealed that: Animation Instructional Strategy (AIS) significantly enhanced the mean achievement and retention scores of the students in Biology more than the conventional chalk and talk method. Equally, the result further revealed that there is no significant difference between the mean achievement and retention scores of male and female students taught biology using AIS. In addition, the interaction between the methods and gender on the students mean achievement and retention scores in Biology was not statistically significant. The similarity between the reviewed study and the current study is that both studies investigated the effect of computer animation instructional strategy on students' achievement and retention. Also, the reviewed and the current studies used mean and standard deviations to answer the research questions and ANCOVA to test the null hypotheses at 0.05 confidence level. However, the current study investigated the effect of computer animation strategy on students' interest whereas the reviewed study did not. In addition, the reviewed study was conducted in Biology while the current study was carried out on Chemistry, a different branch of science.

Odey (2025) examined the effect of Computer-Aided Instruction (CAI) using animation on students' interest in thermal energy among junior secondary school students in Abuja, Nigeria. Employing a quasi-experimental design. The population of the study comprised all Junior Secondary School II (JSS II) students in public secondary schools in Abuja, Nigeria, during the 2023/2024 academic session. A sample of 118 students was drawn using a simple random sampling technique to ensure representativeness. The sample consisted of 55 students in the experimental group (taught with CAI animation) and 63 students in the control group (taught using conventional methods). Data were collected using a Thermal Energy Interest Rating Scale administered before and after the intervention. Analysis of Covariance (ANCOVA) revealed a significant increase in interest levels among students taught with computer animation compared to those taught using conventional methods. No significant gender differences were observed in interest within the animation group. These findings support the use of animation-based CAI as an effective strategy to enhance students' engagement and interest in abstract scientific concepts like thermal energy. The similarity between the reviewed study and the current study is that, both studies examined the effect of computer animation techniques on students' interest. Both the reviewed and the current study adopted the same quasi experimental research design and ANCOVA to test the null hypotheses. However, the current study examined the effect of computer animation techniques on students' academic achievement and retention whereas the reviewed study did

not. In addition, the current study investigated the interaction effect of the strategy and gender on students' interest, retention and achievement while the reviewed study did not. The identified gaps have call for the need to conduct the current study.

Shehu, Akanbi, Yahaya, Yahaya, Adeiyi and Abdulkadir (2024) investigated the effect of animation instruction on senior school students' learning outcomes in atomic and nuclear physics, Kwara State, Nigeria. The study adopted pre-test/post-test quasi-experimental non-randomized, non-equivalent control group. The population of the study was all the SS 3 physics students in Kwara State. Two intact classes (two co-educational public senior secondary schools) were used as study group with a sample size of 177 students. Three research questions and three null hypotheses guided the study. The instrument used for data collection was Atomic and Nuclear Physics Performance Test (ANPPT) and Atomic and Nuclear Physics Retention Test (ANPRT). Mean and standard deviations were used to answer the research questions while t-test and ANCOVA were used to test the null hypotheses at 0.05 level of significance. Findings revealed that computer animation strategy produced significantly higher performance and retention scores in the experimental group compared to the control group. There was significant difference in the mean achievement scores between male and female students taught atomic and nuclear physics using computer animation strategy in favour of the male students. There was significant difference in the mean retention scores between male and female students taught atomic and nuclear physics using computer animation strategy in favour of the male students. There was no interaction effect of gender and animation strategy on students' retention in Physics. The similarity between the reviewed study and the current study is that, both studies investigated the effect of computer animation instructional strategy on students' achievement and retention. The reviewed and the current studies adopted the same quasi-experimental research design. The reviewed study used mean and standard deviation to answer the research questions and ANCOVA to test the null hypotheses at 0.05 level of significance same as the current study. However, the reviewed study did not investigate the effects of computer animation on students' interest whereas as the current study did. In addition, the reviewed study was conducted in Physics whereas the current study is conducted in Chemistry.

Gongden (2023) investigated the effect of gender on senior secondary school two Chemistry students' achievement and retention in chemical equilibrium using computer animation strategy. Quasi-experimental research design was adopted for the study. The study used two experimental groups and randomly assigned students into equivalent groups based on prior achievement measures. The population of the study comprised two equivalent experimental

groups (each group contained 25 males and 25 female students across the design). Three research questions and three null hypotheses guided the study. Chemical Equilibrium Achievement Test (CEAT) was used for data collection and it contains 30 multiple-choice items drawn from past SSCE papers with a reported reliability of 0.78. Mean and standard deviations were used to answer the research questions while t-test was used to test the null hypotheses at 0.05 level of significance. Findings: The study reported a significant difference between male and female students' mean achievement and retention scores when taught using Computer Animation Strategy (CAS), with male achieving/retaining better than their female counterpart. The similarity between the reviewed study and the current study is that both studies investigated the effect of computer animation instructional strategy on students' achievement and retention. Also, the reviewed and the current studies adopted the same quasi-experimental research design. However, the current study investigated the effect of computer animation techniques not only on students' achievement and retention but also on students' interest whereas the reviewed study did not. Another difference is that, the reviewed study used t-test to test the null hypotheses whereas the current study used ANCOVA to test the null hypotheses.

METHODOLOGY

This section discussed the methods that were employed in carrying out the study. It is organized under the following sub-headings: Design of the Study, The Study Area, Population of the Study, Sample and Sampling Technique, Instruments for Data Collection, Validation of the Instruments, Reliability of the Instruments, Method of Data Collection, Control of Extraneous variables and Data Analysis Techniques.

This study adopted a quasi-experimental non-randomized pretest-posttest control group design utilizing intact classes, where an experimental group was exposed to computer animation techniques while a control group was taught using a conventional method. This design was specifically deployed within Education Zone A of Benue State, Nigeriaa region comprising seven local government areas selected due to persistent low academic achievement and fluctuations in secondary school chemistry results.

The target population for the research encompassed 3,041 (1573 males and 1468 females) senior secondary two (SS 2) chemistry students across 85 public co-educational schools in the zone. From this population, a sample of 361 students was selected using a multistage sampling procedure. In the first stage, schools were purposively sampled based on being public, co-educational, science-offering institutions with experienced chemistry teachers,

after which simple random sampling was used to select two schools per local government area and assign them to either the experimental or control conditions. Intact classrooms were preserved entirely to maintain ecological validity and avoid disrupting normal school activities.

Data collection relied on two distinct instruments designed by the researcher: the Organic Chemistry Interest Rating Scale (OCIRS), which used a 20-item four-point scale to measure student interest, and the Organic Chemistry Achievement Test (OCAT), consisting of 40 multiple-choice questions scored out of 80 marks. To measure long-term knowledge retention, the OCAT items were later reshuffled to form the Organic Chemistry Retention Test (OCRT). Before implementation, these instruments underwent face and content validation by three university experts in chemistry education and measurement evaluation, followed by trial-testing on non-sampled student groups. The trial test demonstrated strong reliability, yielding a Kuder-Richardson (K-R20) coefficient of 0.87 for the achievement test and a Cronbach Alpha of 0.88 for the interest scale, both surpassing the standard acceptable threshold.

The actual fieldwork spanned several weeks and was facilitated by regular classroom chemistry teachers who served as research assistants after undergoing a rigorous seven-day training program. Following a baseline pre-test, the treatment phase lasted for seven weeks, during which identical organic chemistry topics were delivered via computer animations for the experimental group and traditional lecture methods for the control group. A post-test was administered immediately after the treatment period, and the retention test followed three weeks later to assess how well the concepts were retained over time.

To ensure the validity of these outcomes, several extraneous variables were strictly controlled. Teacher variability was minimized by providing uniform lesson plans and selecting educators with over five years of experience, while the Hawthorne effect was mitigated by conducting lessons during normal school periods without informing students they were part of an experiment. Additionally, subject interaction was prevented by selecting schools in separate geographical locations, test-retest familiarity was controlled by the seven-week gap between testing periods, and initial group non-equivalence was statistically managed. Ultimately, the collected data were evaluated using mean and standard deviation scores to answer the core research questions, while Analysis of Covariance (ANCOVA) was applied at a 0.05 level of significance to test the null hypotheses.

RESULTS

This section is concerned with data presentation, analysis, interpretation and discussion of findings. The results are presented and analyzed based on the research answered questions and hypotheses tested.

4.1.1 Research Question One: What is the difference in the mean interest ratings of students taught Organic Chemistry using computer animation techniques and those taught using conventional method?

Table 1: Mean and Standard Deviation of Interest Ratings of Students TaughtOrganic Chemistry Using Computer Animation Techniques and those Taught UsingConventional Method (N =361)

Method	N	Pre-test		Posttest		Mean gain
		Mean	SD	Mean	SD	
Computer Animation Technique	180	2.17	.96	3.76	.55	**1.59**
Conventional Method	181	2.18	.96	2.42	.93	**0.24**
Mean difference		**-.01**		**1.34**		**1.35**

Source: Field Work, 2025 (*N = Sample size and SD = Standard Deviation)*

Table 1 shows the mean interest ratings of students taught Organic Chemistry using computer animation techniques and those taught using conventional method. Students taught using computer animation techniques pre-interest mean scores = 2.17 with standard deviation SD =.96 and post-interest mean scores = 3.76, SD = .55 while students taught using conventional method had mean scores = 2.18, SD = .96 at pre-interest and post-interest mean scores = 2.42, SD = .93 respectively. The Table further shows the mean gain of 1.59 for students taught using computer animation techniques and mean gain of 0.24 for students taught using conventional method. The mean difference between the groups was 1.35 in favour of students taught using computer animation techniques. This implies that, students taught using computer animation techniques had higher mean interest compared to students taught using conventional method.

4.1.2 Research Question Two: What is the difference in the mean interest ratings of male and female students taught Organic Chemistry using computer animation techniques?

Table 2: Mean and Standard Deviation of Interest Ratings of Male and Female Students Taught Organic Chemistry Using Computer Animation Techniques (N =180)

Gender	N	Pre-test		Posttest mean		Mean gain
		Mean	SD	Mean	SD	
Male	85	2.12	.61	4.00	.00	**1.88**
Female	95	2.21	1.19	3.55	.70	**1.34**

Mean difference		**-0.09**		**0.45**		**0.54**

Source: Field Work, 2025(*N = Sample size, SD = Standard Deviation)*

Table 2 shows the mean interest ratings scores between male and female students taught Organic Chemistry using computer animation techniques. Male Students taught using computer animation techniques has pre-interest mean scores = 2.12 with standard deviation SD =.61 and post-interest mean scores = 4.00, SD = .00 while female students taught using conventional method had mean interest scores = 2.21, SD = 1.19 at pre-interest and post-interest mean scores = 3.55, SD = .70 respectively. The table further shows the mean gain of 1.88 for male students taught using computer animation techniques and mean gain of 1.34 for female students taught using conventional method. The mean difference between the groups was 0.54 in favour of male students taught using computer animation techniques. This implies that, male students taught using computer animation techniques had higher mean interest as compare to female students

Testing of Hypotheses

4.1.10 Hypothesis One

There is no significant difference in the mean interest ratings of students taught Organic Chemistry using computer animation techniques and those taught using conventional method.

Table 7: Analysis of Covariance of Interest Ratings of Students Taught Organic Chemistry Using Computer Animation Techniques and those Taught UsingConventional Method.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	163.522[a]	2	81.761	139.622	0.000
Intercept	515.667	1	515.667	880.594	0.000
Pretest interest	1.175	1	1.175	2.006	0.158
TREATMENT	162.489	1	162.489	277.479	0.000
Error	209.641	358	0.586		
Total	3817.000	361			
Corrected Total	373.163	360			

Source: Field Work, 2025*(P< 0.05)*

Table 7 shows that, F (1, 360) = 277.479, P = 0.000 < 0.05. Since the P-value is less than the alpha value, the null hypothesis which states that, there is no significant difference in the mean interest ratings of students taught Organic Chemistry using computer animation techniques and those taught using conventional method was rejected. This means that, there is statistical significant difference in the mean interest ratings of students taught Organic

Chemistry using computer animation techniques and those taught using conventional method. Students taught Organic Chemistry using computer animation techniques had higher mean interest ratings than those taught using conventional method.

4.1.11 Hypothesis Two

There is no significant difference between male and female students' mean interest when taught Organic Chemistry using computer animation.

Table 8: Analysis of Covariance of Male and Female Students' Mean Interest in Organic Chemistry When Taught Using Computer Animation Techniques.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	9.585[a]	2	4.792	18.791	.000
Intercept	395.407	1	395.407	1550.343	.000
Pretest interest	.394	1	.394	1.545	.216
GENDER	9.354	1	9.354	36.677	.000
Error	45.143	177	.255		
Total	2601.000	180			
Corrected Total	54.728	179			

Source: Field Work, 2025*(P<0.05)*

Table 8 shows that, F(1, 180) =36.677, P = 0.000 < 0.05. Since the P-value is less than the alpha value, the null hypothesis which states that, there is no significant difference between male and female students' mean interest in Organic Chemistry when taught using computer animation was rejected. This means that, there is statistical significant difference between male and female students' mean interest in Organic Chemistry when taught using computer animation techniques. Male students have higher interest in Organic Chemistry when taught using computer animation techniques than their female counterparts.

FINDINGS

First finding reveals that, there is a significant difference in the mean interest ratings of students taught Organic Chemistry using computer animation techniques and those taught using conventional method. It implies that, students who were taught Organic Chemistry using computer animation instructional strategy showed more interest compared to students taught using conventional method. The observed improvement in interest after instruction with computer animation supports the idea that dynamic visual tools can make abstract concepts like Organic Chemistry more accessible and engaging for students. The finding aligns with Nwotolo, Nwafor, Okpube, Enyi, Nwovu and Ikporo (2025) who found that, Animation Instructional Strategy (AIS) significantly enhanced the mean interest scores of

students in Biology more than the conventional chalk and talk method. The finding also agrees with Odey (2025) whose study revealed a significant increase in interest levels among students taught Thermal Energy with computer animation compared to those taught using conventional methods. The finding also corroborates Egbutu and Okoli (2021) whose finding indicated that computer animation was more effective than inquiry method in improving the interest of students in Chemistry. Similarly, Gongden, Yame and Gongden (2020) indicated that students taught chemical bonding using Animation Instructional Strategy had higher interest in Chemistry than those taught using the conventional method. Furthermore, the finding agreed with Nnorom and Emeka-Ifeanyi (2019) that students taught Biology using computer animation had higher interest than those taught using expository method. The finding is also in agreement with Chikendu (2018) who found that students taught Chemistry using computer animation instructional strategy showed higher interest than those taught using the conventional method.

The second finding revealed that, there is significant difference between male and female students' mean interest when taught Organic Chemistry using computer animation. The mean difference between the groups was in favour of male students taught using computer animation techniques. This means that, male students were more interested in Organic Chemistry when taught using computer animation techniques compared to female students. The finding disagrees with Odey, (2025), Egbutu and Okoli (2021), Gongden, Yame and Gongden (2020), who all revealed that, there is no significant difference between the mean interest scores of male and female students taught using animation instructional strategy. The finding also disagrees with Chikendu (2018) who reported on significant difference in the mean interest scores of male and female students taught Chemistry using instructional computer animation in favour of the female students. The previous studies indicated that both male and female students in the same group developed higher interest. This variation between the previous studies and the current study could be due to the type of research design, statistical tool employed for data analysis and possibly some extraneous variables that could not be put under control during treatment.

CONCLUSION

The study concludes that computer animation techniques are an effective instructional strategy for enhancing students' interest, retention and achievement in Organic Chemistry. There is significant difference between male and female students' mean interest and achievement scores in favour of the male students when taught Organic Chemistry using

computer animation techniques. However, the study found no significant gender differences in retention scores, indicating that computer animation benefits both male and female students equally in terms of retentive ability. There is significant interaction effect of gender and strategy on students' interest and achievement, while the study found no interaction effect of gender and strategy on students' retention in Organic Chemistry.

RECOMMENDATIONS

In line with the findings of this study, the following recommendations were made:

Animation instructional techniques should be given serious consideration by Chemistry teachers because of its proven positive effect on student's' interest, retention and academic achievement in Chemistry and Chemistry teachers should improve on their instructional strategy leveraging on the benefits of animation instructional techniques in order to enhance students' academic achievement and retention in Chemistry.

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