Comparative Effects Of Animated And Non-Animated Computer Assisted Instructional Strategies On Students' Academic Achievement In Basic Science

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Abstract

This study examines the effect of animated and non-animated computer-assisted instructions on students' academic achievement in basic science with the aim of addressing learning challenges in basic science. The study adopts a quasi-experimental research design involving 2,437 junior secondary school students in nsukka local government area, enugu state. Purposive sampling was used to select 85 students (39 males, 46 females) from four schools. Basic science achievement test was used for data collection after its validity was established. The reliability coefficient of 0.93 was obtained for the instrument. Data analysis entails mean,

standard deviation, and analysis of covariance (ancova) at 0.05 significance level of significance. The results indicate significantly higher levels of academic achievement among students taught with animated computer-assisted instructions. Gender was not a significant factor on students' achievement in basic science; the interaction effect of gender and instructional strategies on students' achievement in basic science was not significant. The study recommends among others that the importance of adopting animated cai as a teaching strategy to improve student outcomes in basic science.

Keywords: computer-assisted instruction, animations, non-animated computer-assisted instructions, basic science, gender.

Introduction

Basic science is a subject born out of the desire of nigerian educationists to cultivate an education aligned with the culture and developmental trajectory of the nation (umar, ossom & egbita 2020). It aims to equip students with practical skills essential for effective participation in nation-building. As a fundamental component of the junior secondary school curriculum, basic science plays a pivotal role in laying the groundwork for subjects such as physics, chemistry, and biology in later stages of education. Moreover, it serves as an introduction to the realm of technology. The national policy of education outlines three primary objectives of basic science and technology: to offer pre-vocational guidance for further technological training, to impart literacy in basic science and technology for everyday life, and to foster creativity (federal republic of nigeria, 2013). Despite its significance as the foundation of scientific and technological studies, students' performance in basic science has been reportedly inadequate (umar, ossom & egbita, 2020; mbonu-adigwe & agugoesi, 2021). This poor performance is often attributed to ineffective instructional methods employed by teachers, directly impacting students' academic achievement.

Academic achievement refers to the level at which a student has reached educational objectives, representing their success in an academic setting. It measures the extent to which students attain specific educational goals within a given timeframe. Poor performance in science subjects often leads students to switch to arts and social sciences, resulting in decreased enrolment and retention in science disciplines, which in turn hampers national development. Umar, ossom, and egbita (2020) identified several factors contributing to the low achievement of students in basic science, including curriculum inadequacy, funding issues, challenges with equipment installation, shortage of trained technical teachers, inappropriate educational methods and policies, insufficient facilities and instructional media, and ineffective instructional delivery methods.

Currently, the predominant instructional delivery method used by teachers in nigerian junior secondary schools is the lecture method, which involves the verbal presentation of subject matter. This traditional approach is didactic, stereotypical, and often lacks tangible results. It is commonly referred to as the "talk and chalk" method, where teachers impart information while students passively listen and copy notes from the chalkboard (akpoghol, ezeudu, adzape, & otor, 2016; mbonu & okoli, 2019). This teacher-centric approach prevails throughout the nigerian educational system, except in a few well-equipped private schools that utilise modern information and communication technology (ict) facilities, such as computer labs with internet access, interactive whiteboards, educational software, multimedia resources, and tools for computer-assisted instruction (cai).

Computer assisted instruction (cai) packages are software programs designed for self-education and can serve as valuable teaching aids. Numerous studies have highlighted the effectiveness of computers in facilitating teaching and learning processes. Cai can be deployed in various forms in the classroom, including animated and non-animated approaches. Research has shown that animation, whether in the form of cartoons for entertainment or instructional purposes, can significantly enhance learning outcomes (mbonu-adigwe, eya, umate & attah, 2021). Different types of images combined with text serve distinct functions in constructing mental models, offering more than just passive absorption of knowledge. Animation, blending auditory and visual elements, can aid in encoding, storing, and retrieving information, thereby improving learning efficacy (mbonu-adigwe, eya, umate & attah, 2021; mayer, 2021). Animated instruction appeals to both sight and hearing senses, enhancing learner retention and recall abilities.

The use of animated materials, such as cartoon instruction, streamlines the learning process, leading to quicker mastery and increased retention, safety, and motivation among learners (owolabi & oginni, 2014). Interactive cartoon teaching is efficient, effective, and flexible, fostering communication and engaging multiple senses simultaneously. It provides a concrete basis for understanding abstract concepts and facilitates more meaningful and enduring learning experiences (owolabi & oginni, 2014). With the rise of internet and electronic learning platforms, teachers now have a plethora of innovative methods to present information. The cartoon format allows for the incorporation of animations, moving images, and sound, enriching teaching materials and encouraging student interaction with the subject matter. Pictures and animations breathe life into scientific principles, sparking students' interest in reading and learning about science. On the other hand, non-animated computer-assisted instruction shares many characteristics with animated instruction but lacks motion elements. Both

animated and non-animated approaches have the capacity to captivate and enhance overall learning experiences.

Research has examined the effects of different modes of computer assisted instruction (cai) on students' achievement in science subjects such as chemistry, physics, and biology. However, findings have yielded discrepancies among researchers in science education. For instance, ezenwa and anyanwu (2014) found no statistically significant difference in post-test mean scores of students taught solid geometry using animated and non-animated modes of cai. In contrast, bamidele and yoade (2017) observed a significant difference in the academic achievement of biology students taught with animated versus non-animated cai, favouring the animated group. Thus, there remains uncertainty regarding the effects of different cai modes on students' achievement in various science disciplines. Consequently, further exploration is warranted to understand the effect of animated and non-animated cai instructions on students' achievement in basic science especially with respect to gender.

Gender is considered a potential moderating variable because of socialization patterns, prior exposure to digital tools, and differences in spatial skills that may shape how learners engage with animated or non-animated multimedia (gupta, marcus, & ayres, 2022; qazi et al., 2021). Several studies report that gender does not significantly predict achievement in cai settings. For instance, özkan (2025) found that virtual reality–based cai improved science achievement across all learners without notable gender differences. Similarly, local studies in nigeria showed that both male and female students benefited equally from cai in biology, suggesting that access to digital resources may reduce traditional gender gaps (unizik journal of stm education, 2025). These findings indicate that cai can be equally effective in supporting academic performance for both genders when resources are comparable. Overall, the literature indicates that while gender differences in achievement under cai are often negligible, gender can moderate achievement depending on instructional design, spatial demands, and context. These mixed findings highlight the importance of investigating gender interactions in specific curricular contexts, such as nigerian basic science classrooms, to better understand how male and female students respond to animated and non-animated cai.

Statement of the problem

The poor and inconsistent academic performance of students in basic science is a concerning issue that has garnered attention from various stakeholders in the education sector and researchers alike. Analysis of results from the basic examination certificate examination (bece) over time has consistently revealed

subpar performance in basic science among candidates. Without urgent intervention, this trend is likely to persist. Despite innovations in teaching and learning methods documented in the literature, academic achievement in basic science continues to decline. This ongoing decline may stem from ineffective teaching methods and strategies employed by teachers.

Efforts to enhance students' achievement in basic science have prompted the exploration of potentially effective instructional approaches, such as computer-assisted instruction. Existing literature suggests that computers can be utilised in the classroom through various means, including animated and non-animated computer-assisted instructions. However, there is a significant dearth of empirical evidence regarding the comparative effects of animated and non-animated computer-assisted instruction on junior secondary school students' achievement in basic science, particularly in the nsukka education zone of enugu state. Furthermore, the influence of gender on students' achievement in basic science, which has been reported in literature with conflicting findings, has yet to be empirically investigated in the context of teaching basic science using animated and non-animated computer-assisted instructions.

Consequently, the primary problem addressed in this study is: can the implementation of animated and non-animated computer-assisted instruction lead to improvements in junior secondary school students' achievement in basic science? This study seeks to provide valuable insights into the efficacy of different modes of computer-assisted instruction in enhancing students' academic performance in basic science, as well as to explore potential gender differences in this regard.

Purpose of the study

The study determined the comparative effects of animated and non-animated computer assisted instructional strategies on students' academic achievement in basic science in nsukka local government of enugu state, nigeria. Specifically, the study sought to determine the;

1. Mean achievement scores of students taught basic science using animated and non-animated computer assisted instructional strategies;
2. Mean achievement scores of male and female students in basic science;
3. Interaction effect of gender and instructional strategies on students' achievement in basic science.

Research questions

The following research questions guided the study.

1. What are the mean achievement scores of students taught basic science using animated and non-animated computer assisted instructional strategies?

2. What are the mean achievement scores of male and female students in basic science?

Hypotheses

The following null hypotheses were tested at 0.05 level of significance;

Ho_1: there is no significant difference in the mean achievement scores of students taught basic science using animated and non-animated computer assisted instructional strategies.

Ho_2: there is no significant difference in the mean achievement scores of male and female students in basic science.

Ho_3: there is no significant interaction effect of gender and instructional strategies on students' achievement in basic science.

Methodology

The study employed a quasi-experimental research design, specifically utilizing a pre-test, post-test non-equivalent control design. It was conducted in nsukka local government area of enugu state, nigeria. The target population consisted of 2,437 junior secondary school ii (jss ii) basic science students, comprising 1,103 males and 1,334 females, enrolled in public secondary schools within nsukka local government area. A sample of size of eighty-five (85) jss ii basic science students was sampled for the study. Schools sampled for the study was based on superior ict facilities compared to other schools in the area. Basic science achievement test (bsat) comprising 30 items, developed by the researchers was used for data collection in the study. The kuder-richardson formula twenty (k-r20) was used to establish the reliability coefficient of bsat (0.93), given its dichotomously scored responses.

Experimental procedure

Experimental procedures involved seeking permission from school principals to conduct the study with jss ii basic science students. Pre-test administration of the bsat preceded the experimental treatments. The study spanned four weeks, with the first week dedicated to training of the research assistants, then followed the administration of the pre-test administration and the commencement of experimental treatments. The final week saw post-test administration, with the bsat being re-administered to students to avoid response bias.

Method of data analysis

Data analysis utilized spss version 25, with mean and standard deviation used to address research questions. Hypotheses were tested using analysis of covariance (ancova) at an alpha level of 0.05. A p-value below 0.05 indicated significance, leading to the rejection of the null hypothesis, while a p-value equal to or greater than 0.05 signified nonsignificance and the retention of the null hypothesis.

Results

Research question one

What are the mean achievement scores of students taught basic science using animated and non-animated computer-assisted instructional strategies?

Table 1: mean and standard deviation of students' achievement scores in basic science using animated and non-animated computer-assisted instructional strategies

Instructional strategies	N	Pretest		Posttest		Mean gain
		$\bar{x}$	Sd	$\bar{x}$	Sd	
Acai	42	20.48	2.64	56.10	6.35	35.62
Nacai	43	20.14	3.13	45.07	8.48	24.93

Note: acai: animated computer-assisted instructional strategy; nacai: non-animated computer-assisted instructional strategy

Result in table 3 shows the mean and standard deviation achievement scores of students taught basic science using animated computer assisted instruction (acai) and non-animated computer assisted instruction (nacai). Result shows that the acai group had mean achievement score of 20.48 with standard deviation of 2.64 at pretest and mean achievement score of 56.10 with standard deviation of 6.35 at posttest recording a mean gain of 35.62. Again, the group taught basic science using nacai had mean achievement score of 20.14 with standard deviation of 3.13 at pretest and mean achievement score of 45.07 with standard deviation of 8.48 at posttest recording a mean gain of 24.93. Also, the results showed that the pretest standard deviations for the two groups were smaller than the posttest standard deviations. This means that the pretest scores of the respondents were more homogeneous in each case and cluster around the means than the posttest scores. For each of the groups, the post-test mean scores were greater than the pretest mean scores with acai group having a higher mean gain (35.62). This is an indication that acai enhances students' achievement in basic science more than nacai (24.93).

Research question two

What are the mean achievement scores of male and female students in basic science?

Table 2: mean and standard deviation (sd) of male and female students' achievement in basic science

Gender	N	Pretest		Posttest		Mean gain	Mean gain diff
		$\bar{x}$	Sd	$\bar{x}$	Sd		
Male	38	20.50	3.66	57.60	3.25	37.10	1.73
Female	47	20.45	2.52	55.82	7.61	35.37	

The result presented in table 2 shows the mean and standard deviation achievement scores of male and female students in basic science. Result shows that the male students had mean achievement score of (mean = 20.50, sd = 3.66) at pretest and mean achievement score of (mean = 57.60, sd = 3.25) at posttest recording a mean gain of 38.10. On the other hand, the female students had mean achievement score of (mean = 20.45, sd = 2.52) at pretest and mean achievement score of (mean = 55.82, sd = 7.61) at posttest recording a mean gain of 35.37. Conclusively, the result shows that male students had higher achievement score in basic science.

Hypothesis one

There is no significant difference in the mean achievement scores of students taught basic science using animated and non-animated computer assisted instructional strategies.

Table 3: summary of analysis of covariance (ancova) of students' achievement in basic science when exposed to animated and non-animated computer assisted instructional strategies

Source	Type iii sum of squares	Df	Mean square	F	Sig.	Partial eta squared
Corrected model	2271.023[a]	4	567.756	14.509	.000	.420
Intercept	2206.417	1	2206.417	56.384	.000	.413
Pretest	.596	1	.596	.015	.902	.000
Method	2091.757	1	2091.757	53.454	.000	.401
Gender	81.617	1	81.617	2.086	.153	.025
Method * gender	365.919	1	365.919	9.351	.172	.105
Error	3130.553	80	39.132			
Total	67962.000	85				
Corrected total	5401.576	84				

Result of the analysis in table 3 shows that instructional strategy is a significant factor on students' achievement in basic science; f (1,80) = 53.454, p = .000. Thus, the null hypothesis of no significant difference in the mean achievement scores of students taught basic science using animated and non-animated computer assisted instructional strategies was rejected. This is because the exact probability value (.000) is less than level of significance set at 0.05. Therefore, the researchers conclude that there is a significant difference in the mean achievement scores of students taught basic science using animated and non-animated computer assisted instructional strategies.

Hypothesis two

There is no significant difference in the mean achievement scores of male and female students in basic science.

Result of the analysis in table 3 was also used to test hypothesis two. The table shows that gender is not a significant factor on students' achievement in basic science; f (1, 80) = 2.086, p = .153. Therefore, the null hypothesis of no significant difference was accepted because the exact probability level of .153 is greater than level of significance set at 0.05. The researchers therefore, conclude that there is no significant difference in the mean achievement scores of male and female students in basic science. The result indicated that gender is not a significant factor in the mean achievement scores of male and female students in basic science.

Hypothesis three

There is no significant interaction effect of gender and instructional strategies on students' achievement in basic science.

the result of the analysis in table 3 was also used to test hypothesis three. The table shows that the exact probability value of .920 associated with method and gender is greater than 0.05 level of significance; (f (1, 80) = 9.351, p =.172). Thus, the null hypothesis of no significant interaction effect of gender and instructional strategies on students' mean achievement scores in basic science is upheld. The researchers therefore, conclude that the interaction effect of gender and instructional strategies on students' achievement in basic science was not significant. The result of interaction effect was also interpreted using screen plot as shown in figure 1 below.

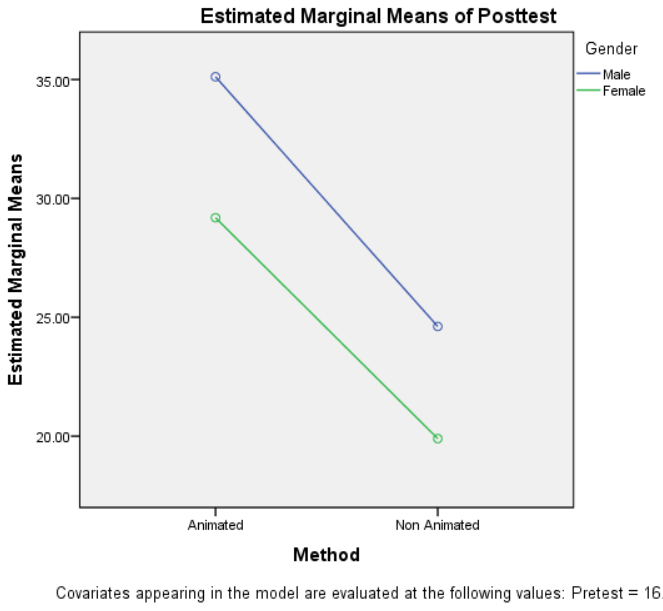

Figure 1: graph of the interaction effect of gender and instructional strategies on students' achievement in basic science

The screen plot in figure 1 shows that there is no interaction effect of gender and instructional strategies on students' achievement in basic science. This is indicated by the separate lines for the male and female students' achievement in basic science in the respective two strategies (that is, the connecting cell mean in the diagram is parallel).

Discussion of findings

Effects of animated computer assisted instruction and non-animated computer assisted instruction on students' achievement in basic science

The findings of the study revealed that while both computer-assisted instructions contributed to enhancing students' academic achievement, those who were taught basic science using animated computer-assisted instruction achieved significantly higher scores compared to those taught with non-animated computer-assisted instruction. The elevated mean achievement score observed in students instructed through animated computer-assisted instruction may be attributed to the inherent strength of this method in presenting information vividly through text, graphics, and sound motion. This feature allows the computer to accommodate various responses, fostering active participation and interaction from learners to receive immediate feedback and proceed at their own pace (gambari, yaki, gana & ughovwa, 2014). Consequently, teaching approaches such as animated computer-assisted instruction, which engage multiple senses of learners, stimulate students' interest, resulting in improved academic performance.

This outcome aligns with samuel and nurudeen (2019), who found significant differences in the achievement of upper basic iii students taught basic science concepts using multimedia-animated instructional strategy. This strategy alleviates students' learning challenges arising from difficulties in conceptualizing and visualizing events at the sub-microscopic level. Similarly, the findings corroborate those of mbonu-adigwe, eya, umate & attah, 2021, who observed a significant difference in the achievement of students taught using computer-based strategies compared to those taught through lectures. Consistent with these findings, egbutu and okeke (2021), mbonu-adigwe & ude (2023), and mbonu-adigwe, agada-shaibu & arua (2024) reported a significant positive effect on students' achievement when instructed using various forms of computer-assisted instruction. Additionally, owolabi and oginni (2014) noted a significant difference in the performance of students exposed to cartoon-style multimedia teaching compared to those taught using conventional methods. This may be attributed to the colourful and engaging nature of the animated computer-assisted instruction

software used in this study, which captured students' attention and consequently led to significantly better outcomes compared to the non-animated group.

Influence of gender on students' achievement in basic science

This suggests that gender did not play a determining role in students' academic achievement in the subject. Both male and female students appeared to have equal opportunities to learn, and they benefitted similarly from the teaching and learning processes. The result further suggests that long-held stereotypes about male students performing better in science subjects than their female counterparts may be gradually eroding. This can be attributed to increasing awareness of gender equality in education, reforms in curriculum implementation, and supportive policies that encourage female participation in science and technology education. This outcome aligns with the position of adebayo and ogunlade (2019), who reported that when instructional strategies and learning environments are conducive, gender differences in achievement tend to diminish.

The finding supports the assertion of okoye and okwelle (2020) that students' achievement in science is more influenced by factors such as teacher quality, availability of instructional resources, and effective teaching methods than by gender. The result further suggests that long-held stereotypes about male students performing better in science subjects than their female counterparts may be gradually eroding. This can be attributed to increasing awareness of gender equality in education, reforms in curriculum implementation, and supportive policies that encourage female participation in science and technology education. However, this finding contradicts studies such as adeyemi (2016), which found slight gender variations in achievement in science. The inconsistency indicates that gender influence on achievement may not be universal but context-dependent, influenced by cultural, environmental, and pedagogical factors.

Interaction effect of gender and instructional strategies on students' achievement in basic science

The findings of the study revealed that the interaction effect of gender and instructional strategies on students' achievement in basic science is not significant. This implies that irrespective of whether a student is male or female, the instructional strategies employed did not produce different levels of achievement between the genders. In other words, both male and female students benefitted equally from the instructional strategies used in the study. This finding suggests that instructional strategies in basic science can be applied without bias or modification along gender lines. It supports the view that when learners are provided with equal learning opportunities, their achievement is more influenced

by the quality of the instructional approach rather than by gender differences (adebayo & ogunlade, 2019). The result aligns with the assertion of adeyemi (2016) that effective teaching strategies are gender-neutral in their impact on students' learning outcomes.

The non-significant interaction effect also indicates that gender does not moderate the relationship between instructional strategy and achievement in basic science. This outcome is consistent with research evidence that cognitive abilities and potential for achievement in science subjects are not inherently gender-dependent but rather shaped by environmental, instructional, and motivational factors (okoye & okwelle, 2020). It further implies that when modern, learner-centered instructional strategies are utilized, they help to bridge achievement gaps and ensure inclusivity in science classrooms.

Conclusion

The study concluded that although both animated and non-animated computer-assisted instruction (cai) improved students' academic achievement in basic science, animated cai proved more effective in significantly enhancing students' achievement. This suggests that the dynamic and interactive nature of animation makes abstract scientific concepts easier to comprehend and retain compared to static, non-animated presentations. Therefore, the integration of animation into computer-assisted instructional strategies holds greater potential for fostering deeper learning, sustained engagement, and improved achievement among secondary school students in basic science.

Recommendations

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

1. Teachers should integrate animated computer-assisted instructional strategies into basic science lessons to enhance students' achievement.
2. Instructional designers should incorporate supportive narration, contextual cues, and relatable examples that appeal to both male and female learners, reducing gender disparities in engagement and outcomes.
3. Continuous efforts should be made by teachers and curriculum planners to create equitable classroom practices that encourage both male and female students to participate fully and benefit maximally from innovative instructional strategies.
4. Government, educational authorities, and school administrators should organize workshops and seminars to train teachers on how to design, adapt, and effectively use animated instructional software in the classroom.

5. Schools should be adequately equipped with computers, projectors, and reliable electricity/internet access to facilitate the effective use of animated cai in teaching and learning.

References

1. Akpoghol, t.v., ezeudu, f.o., adzape, j.n. & otor, e.e. (2016). Relative effect of lecture method supplemented with music and computer animation on senior secondary school students' retention in electrochemistry. *Journal of education. & practice, 7*(4), 87 - 95. Https://files.eric.ed.gov/fulltext/ej1092390.pdf
2. Ani, i.a., obodo, a. C., ikwueze, c.c., & festus, i. T. (2021). Effect of gender on basic science students' academic achievement in secondary schools in enugu education zone, enugu state, nigeria. *Unizik journal of educational research and policy studies, 2*(1), 9-14 https://unijerps.org/index.php/unijerps/article/view/195
3. Bamidele e. F. & yoade f. B. (2017). Effects of modes of computer animation instructional packages on students' achievement in osun state secondary schools' biology. *International journal of innovation and research in educational sciences,* 4 (4), issn (online): 2349–5219 https://www.ijires.org/administrator/components/com_jresearch/files/publications/ijires_1017_final.pdf
4. Adebayo, f. A., & ogunlade, o. O. (2019). Influence of gender on students' academic achievement in science subjects in secondary schools. *International journal of education and research, 7*(4), 123–132.
5. Okoye, k. R. E., & okwelle, p. C. (2020). Improving students' achievement in science, technology, and mathematics education through effective instructional strategies. *Nigerian journal of curriculum studies, 27*(2), 112–124.
6. Adeyemi, b. A. (2016). Effect of gender on students' academic achievement in secondary school social studies. *Journal of education and practice, 7*(8), 91–97.
7. Egbutu, r.n., & okeke, s.o.c. (2021). Effects of computer animation and inquiry method on chemistry students' critical thinking and achievement in onitsha education zone. *Iosr journal of research & method in education (iosr-jrme) 11*(2): 42-48. Https://www.iosrjournals.org/iosr-jrme/papers/vol-11%20issue-2/series-3/g1102034248.pdf
8. Federal republic of nigeria (2013). *National policy on education*. Abuja: nerdc
9. Gambari, a. I., falode, c.o., & adegbenro, d.a. (2014). Effectiveness of computer animation and geometrical instructional model on mathematics achievement and retention among junior secondary school students. *European journal of science and mathematics education, 2*(2), 127-146. Https://files.eric.ed.gov/fulltext/ej1107644.pdf
10. Hassan, a. M., kareem, w. B., mohammed, b. M. (2016). *Effect of ict on achievement and interest of junior secondary school students in basic science*

and technology. A paper presented at the 29th annual national conference of the science teachers association of nigeria (stan) held at government college, ado ekiti, 15-20 august 2016. 363-368

11. Ikwuka, o. I., & samuel, n. N. C. (2017). Effect of computer animation on chemistry academic achievement of secondary school students in anambra state, nigeria. *Journal of emerging trends in educational research and policy studies, 8*(2), 98-102. Https://www.researchgate.net/publication/327350923_effect_of_computer_animation_on_chemistry_academic_achievement_of_secondary_school_students_in_anambra_state_nigeria
12. Mayer, r. E., & fiorella, l. (eds.). (2021). *The cambridge handbook of multimedia learning* (3rd ed.). Cambridge: cambridge university press. Https://www.cambridge.org/core/books/cambridge-handbook-of-multimedia-learning/c1c0b00fe70dc11afdc1f9e1782b5b77
13. Mbonu, b.u. & okoli, j.n. (2019). *Effects of multimedia integrated instruction on basic science students' academic achievement in anambra state*. 60th annual conference proceedings of the science teachers association of nigeria (stan), 229-237.
14. Mbonu-adigwe, b.u. & agugoesi, o.j. (2022). *Assessment of basic science students' level of entrepreneurial skills acquisition in enugu state, nigeria.* 62nd annual conference proceedings of the science teachers association of nigeria (stan), 54-61.
15. Mbonu-adigwe, b.u., eya, n., umate, bukar & attah, f.o. (2021). Effects of multimedia integrated instruction on students' acquisition of science process skills in basic science. *African journal of science technology and mathematics education, 6 (1),* 46-55 https://www.researchgate.net/publication/350690050_effects_of_multimedia_integrated_instruction_on_students%27_acquisition_of_science_process_skills_in_basic_science
16. Nnorom, n. R. & emeka-ifeanyi, o.h. (2021). The effect of computer animation on secondary school students' interest and academic achievement in biology in anambra state. *Coou journal of science education and allied discipline,* 116 – 127. Issn (print): 2635-3083 file:///c:/users/admin/downloads/12-48-1-pb.pdf
17. Nwosu, o., & ndanwu, a. I. (2020). Interaction effect of gender and teaching method on academic achievement and interest of students in the electronic libraries course in federal tertiary institutions in anambra state, nigeria. *Journal of applied information science and technology 13*(1). Https://www.jaistonline.org/13vol1/30.pdf
18. Owolabi, o. T., & oginni, o. I. (2014). Effectiveness of animation and multimedia teaching on students' performance in science subjects. *British*

journal of education, society & behavioural science, 4(2), 201-210. Https://www.researchgate.net/publication/341188704_effectiveness_of_animation_and_multimedia_teaching_on_students%27_performance_in_science_subjects

19. Samuel, r. I. (2018). Effect of multimedia instructional approach on mid-basic 2 pupils' interest and retention in basic science. *International journal of scientific and research publications, 8*(11), 343-348. Https://www.ijsrp.org/research-paper-1118/ijsrp-p8339.pdf
20. Samuel, r. I., & nurudeen, j.i. (2019). Effect of multimedia-animated instructional strategy on upper basic iii students' interest, achievement, and retention in basic science. *International journal of innovative information systems & technology research 7*(1), 27-33. Https://seahipaj.org/journals-ci/mar-2019/ijiistr/full/ijiistr-m-5-2019.pdf
21. Siddiq, f., scherer, r., & tondeur, j. (2019). Is there a gender gap? A meta-analysis of the gender differences in students' ict literacy. *Computers & education, 135,* 1–12.
22. Umar, b.k., ossom, m.o., & egbita, a.u. (2020). Impact of multimedia instructional strategies on students' achievement and retention in basic science and technology in minna, niger state. *International journal of research and scientific innovation (ijrsi), 7*(6). Https://www.rsisinternational.org/journals/ijrsi/digital-library/volume-7-issue-6/150-155.pdf