

Effects of Play-Learn-Act-Now Game and Concept Mapping Instructional Strategies on Students' Achievement in Basic Science Climate Change Concepts

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Abstract

This study examined the effects of the Play-Learn-Act-Now game and concept mapping instructional strategies on students' academic achievement in basic science climate change concepts. A quasi-experimental, non-equivalent pre-test, post-test, non-randomized design was adopted. The population consisted of 5,773 Upper Basic 3 students (2,063 males and 3,710 females), from which a sample of 188 students (92 males and 96 females) was drawn. Data were collected using the Climate Change Achievement Test (CCAT), which had a reliability coefficient of 0.81 using Kuder-Richardson Formula 20 (K-R20). Findings revealed no significant difference in performance between students taught using the Play-Learn-Act-Now game and those taught through concept mapping ($p = 0.799 > 0.05$). There was also no significant gender-based difference for the Play-Learn-Act-Now game ($p = 0.089 > 0.05$) and concept mapping ($p = 0.533 > 0.05$), although female students performed slightly better. It was recommended that both strategies be adopted in teaching climate change concepts.

Key Words: Academic achievement, and concept mapping, climate change concepts, instructional strategies, Play-Learn-Act-Now game strategy.

Introduction

Basic Science is a foundational subject within the Nigerian Basic Education Curriculum, taught at the basic education level. As stated by the Nigerian Educational Research and Development Council (2024), it presents scientific ideas and phenomena to students in an integrated manner. According to Ode and Fakaa (2023), the subject aims to provide a solid foundation for future studies in more specialized science disciplines at the senior secondary and tertiary levels. Additionally, Basic Science is designed to equip learners with a wide range of scientific knowledge and practical skills, enabling them to actively engage in solving societal problems such as climate change, in alignment with the objectives of science education.

Climate change is a scientific phenomenon and one of the many pressing global issues currently affecting the physical environment. According to Intergovernmental Panel on Climate Change (IPCC, 2021), climate change deals with matter, the factors causing changes in the states of matter and the

differential properties and effects of matter in its different states. Climate change encompasses the interaction of Carbon, Oxygen and Hydrogen in different states and the impacts of associated compounds on weather elements and the environment.

Benue State located in Central Nigeria has suffered localised impacts of climate change, most notably seasonal flash-floods due to increasing intensity of torrential rainfall. This results in displacements, destruction of farmlands and interruption of learning in especially basic education schools which are often used as temporary camps for displaced persons. This research cites a 2024 flood situation report for Benue State, published by the International Organisation for Migration (IOM, 2024) in partnership with the Benue State Emergency Management Agency (BENSEMA). The report emphasized that children aged 1 to 17 years, aligning with those in the basic education category, make up a large segment of the population that needs focused attention on their education, nutrition, and other

vital needs. The report further indicated that Makurdi Local Government Area, which serves as the study's geographical focus, recorded the highest percentage of affected individuals, accounting for 46% of the total impacted population. Historically, Makurdi Local Government Area has suffered severe impacts of flooding notably the 2012 and 2022 floods. Kumar et al. (2023) noted the centrality of education in increasing climate literacy, understanding and response to the localised impacts of climate change. Yet, the IOM (2024) report failed to highlight education as a first line intervention despite the centrality of education in addressing the root cause of flooding in Makurdi.

Evidence of the Nigerian government's efforts to promote climate change education is manifest by the approval for the infusion of Environmental Education (EE) topics, under which climate change is subsumed into the primary, secondary and adult education curricula. This involves the incorporation of Environmental Education (EE) into the Basic Science curriculum by the Nigerian Educational Research and Development Council (NERDC). However, despite these initiatives, Okonkwo and Samuel (2021), referencing the works of Osuafor (2014) and Adekola et al. (2017), reported that the implementation of EE topics, intended to tackle environmental issues—has not been carried out with sufficient commitment or clarity of purpose. As a result, the integration of EE concepts into the school curriculum does not seem to be yielding the expected outcomes. Given the lack of evidence suggesting otherwise, it appears that Nigeria, one of the countries most vulnerable to the effects of climate change, may not be adequately educating students about climate-related issues in schools, which could explain the persistent climate change impacts experienced nationwide.

The lack of emphasis on climate change, particularly within the Basic Science curriculum, may partly explain the persistent decline in students' academic achievement in the subject. There has been hue and cry over the poor trend in students' achievement in the subject as shown in the Basic Education Certification Examination results (Universal Basic Education Commission, 2020; Benue State Examinations Board, 2018-2023). Academic achievement entails attainment of goals set for a learner from lessons taught which may include experiences, knowledge and skills. Ode and Eriba (2020) opined that students' cognitive outcomes are represented by achievement in school subjects estimated by the grades obtained in a test or end of term examination.

Studies link poor achievement in Basic Science to a range of instructional and resource-related challenges. For instance, previous researchers on students' achievement in Basic Science (Udu et al. 2016; Achor & Musa, 2022; Ajio et al. 2023) attributed students' poor achievement in the subject to inadequate exposure of students to practical activities, inadequate preparation of students for external examinations and inability to comprehend questions, use of inadequate gender sensitive strategies/materials, inappropriate teaching methods and inability of Basic Science teachers to apply innovation in teaching and learning of the subject.

In particular, several scholars have singled out the reliance on ineffective teaching strategies as a key driver of poor student outcomes in Basic Science. Ajayi and Ogbeba (2017); Muodumogu and Gwang (2020); Achor and Musa (2022); Anari et al. (2023) identified the use of defective teaching strategies as a prominent factor of poor students' achievement at the basic education level, especially in Basic Science and other science subjects. In a bid to address the problem, Anita (2015); Agernor (2016); Ajayi and Ogbeba (2017); Achor and Musa (2022); Kpiranyam et al. (2023) investigated and offered recommendations on the effective, innovative strategies which hold the promise to improve the achievement of students in science.

Despite the efforts of stakeholders in science education, the poor academic achievement in science concepts by students have defied available solutions. It appears that there exists a gap in translating research findings into actionable and implementable steps in the classroom due to operational and other systemic inadequacies. It may also appear that the problem has persisted as a result of yet an untried instructional strategy like the Play-Learn-Act-Now (P-L-A-N) strategy

Play-Learn-Act-Now (P-L-A-N) game is an instructional strategy rooted in gamification which incorporates interactive and experiential learning methods to promote active engagement with content. It provides students with opportunities to simulate real-world scenarios through play, role-taking and decision-making. This strategy could support affective and cognitive learning by fostering motivation and engagement while enhancing understanding of complex topics (Gee, 2018). Anastasiadis et al. (2018) observed that game-based learning improves conceptual understanding and promotes deeper involvement in science learning. The P-L-A-N game is an environmental card game which could be used in

teaching climate change and environmental related concepts in Basic Science to ascertain its effect in fostering behavioural change and cognitive ability of students. P-L-A-N game was developed by Ecocykle Development Foundation in 2023 to expose learners to environmental problems and their solutions.

Another variable considered in this study is concept mapping. Concept mapping is another constructivist teaching strategy that could promote students' active participation in class and learning gains. Novak and Gowin (1984) opined that a concept map is a schematic device used to represent a set of concept meanings embedded in a framework of propositions, a two-dimensional hierarchical diagram which clearly shows the interconnection between and among individual concepts. It helps learners visualise cause-effect relationships and hierarchical structures in scientific phenomena (Novak & Cañas, 2018). Concept mapping has been found to improve students' comprehension and ability to retain scientific ideas (Broman & Parchmann, 2014). Therefore, it holds promise for enhancing the teaching and understanding of climate change concepts. According to Kpiranyam et al. (2024), a concept map constructed in the class provides graphical representation, major information, ideas and how they are related. Thus, may be useful in enhancing students' academic achievement regardless of their gender.

Gender has been reported as a major factor that could influence students' learning with particular regard to science education. Agogo and Naakaa (2014) defined gender as the set of socially assigned characteristics that distinguish females from males. Agernor (2016) construed gender as a sense of awareness of being male or female and the roles that are attached to each group in the society. Gender stereotypes exist in learning in science classrooms. For instance, Anekwe (2016) observes that content areas like force, gravity, pendulum, and thermodynamics are closer to experiences which would have or may have in the course of their development. Studies on gender by Voyer and Voyer (2014); Hashim et. al. (2015), Ani et. al. (2021) and Baba et. al. (2022) yielded conflicting findings on the achievement of male and female students in science. Due to the conflicting findings generated from the aforementioned studies, and the scarcity of research reports on P-L-A-N game instructional strategy this study examined the effects of P-L-A-N game and the use of concept mapping teaching methods on students' academic performance in climate change topics within Basic Science in Benue

State, Nigeria. Specifically, the study answered the following questions.

Research Questions

The study was guided by the following questions:

1. Does the average academic achievement scores between students taught climate change concepts using the P-L-A-N game and those taught using concept mapping strategies in Basic Science differ?
2. What differences exist in the mean achievement scores of male and female students taught climate change concepts with the P-L-A-N game instructional strategy in Basic Science?
3. What are the differences in mean achievement scores between male and female students taught climate change concepts through the concept mapping instructional strategy in Basic Science?

Hypotheses

The following null hypotheses were tested at a 0.05 significance level:

1. There is no significant difference in the average achievement scores between students taught climate change concepts via the P-L-A-N game and those taught through concept mapping in Basic Science.
2. There is no significant difference in mean achievement scores between male and female students taught climate change concepts using the P-L-A-N game strategy in Basic Science.
3. There is no significant difference in academic achievement between male and female students taught climate change concepts using the concept mapping strategy in Basic Science.

Research Design

The study utilized a non-equivalent pre-test and post-test quasi-experimental design without randomization. This approach was chosen to avoid disrupting the school timetable or reorganizing classes, hence the use of existing intact classes for the research. Emaikwu (2015) supports the use of non-equivalent control group design when it is not possible to randomise as in true experiments. The two groups used in the research were both experimental groups.

Population, Sample and Sampling

The study population consisted of 5,773 Upper Basic 3 students (2,063 males and 3,710 females) enrolled in public schools within Makurdi Local Government Area, Benue State during the 2024/25

academic year (Benue State Ministry of Basic Education, Makurdi, 2025). The sample included 188 Upper Basic 3 students (92 males and 96 females) drawn from two co-educational government schools. A multi-stage sampling technique was employed. Initially, purposive sampling was used to select one local government area within the Makurdi Education Zone. Subsequently, purposive sampling was applied again to choose two schools that met specific criteria: they had to be government-established co-educational upper basic schools to address gender balance and have qualified Basic Science teachers with at least a National Certificate in Education (NCE) and a minimum of five years teaching experience.

Next, the hat-and-draw method without replacement was utilized to randomly select two Upper Basic schools. Following this, the same method was applied to randomly assign one school to Experimental Group I and the other to Experimental Group II. This was done by writing the names of the selected schools on separate pieces of paper, placing them in a hat, and mixing them. The first school drawn was designated Experimental Group I, while the second was assigned to Experimental Group II. This procedure aimed to eliminate selection bias.

Instrumentation, Validation and Reliability of Instrument

The researchers developed the Climate Change Achievement Test (CCAT) using content from Basic Science textbooks. Section A gathered personal information from the participants, including their gender and school name, while Section B included 25 multiple-choice questions, each with four answer options labeled A to D. The test was scored out of 25, awarding one mark for each correct response and zero for incorrect answers.

To ensure face and content validity, the test instrument and lesson plans were reviewed by five experts. These experts provided qualitative feedback, after which the items were pilot tested and subjected to psychometric analysis. All corrections were incorporated to improve the quality of the instrument. The reliability coefficient of CCPT items were subjected to reliability test using Kuder-Richardson formula 20 (K-R 20) which yielded a reliability coefficient of 0.81. Based on the benchmark by Emaikwu (2015), of 0.7 the items were considered reliable.

Method of Data Collection

The researcher visited the two selected schools and obtained approval from the principals. Data collection was conducted over a five-week period during the second term of the 2024/2025 academic session. In the initial week, two Upper Basic 3 teachers—each with a B.Ed. in Basic Science and over 15 years of teaching experience—were trained. During this same week, the Climate Change Performance Test (CCPT) was administered as a pre-test to all participant groups. The intervention began in the first week and continued for six weeks, with the post-test (CCPT) administered in the fifth week.

The instruction on climate change concepts using the P-L-A-N game strategy involved several steps: the teacher first assessed learners' characteristics and their prior knowledge, set clear learning objectives, and selected suitable P-L-A-N game cards. These objectives were then integrated with the game content. Students were divided into heterogeneous groups, with each group actively participating by taking turns to play cards related to climate change problems and solutions. The teacher leveraged the engaging nature of the game to stimulate students' interest and encouraged active participation and contribution during the lessons. The teacher also carried out progressive and end of session assessments of learning respectively as scheduled.

The teaching of climate change concepts using concept mapping instructional strategy was done as follows: teacher guided students to create concept maps, compare their maps and make corrections where necessary. Teacher then explained the concepts taught, putting into consideration all the students' contribution, asking questions which students answered with the teacher acting as guide. The study utilized regular teachers from the selected schools. The two groups were drawn from different schools situated in separate locations, with a reasonable distance between them.

Method of Data Analysis

To address the research questions, mean and standard deviation were employed. The hypotheses were tested using Analysis of Covariance (ANCOVA) at a 0.05 significance level. A null hypothesis was rejected if the p-value was less than or equal to 0.05; otherwise, it was retained. Since intact classes with unknown equivalence were used, any differences observed in the outcomes is as a result of the impact of the independent variable on the dependent variable.

Results

The results of the data analysis and interpretation are presented as follows:

Research Question One

Table 1: Students' Achievement Scores in Basic Science Climate Change Concepts Using P-L-A-N Game and Concept Mapping Teaching Methods

Group		Pre-Test			Post-Test		Mean Gain
	N	\bar{x}	SD		\bar{x}	SD	
P-L-A-N Game Strategy	97	11.07	3.46		17.18	4.14	6.11
Concept Mapping Strategy	91	10.78	3.09		17.00	6.43	6.22
Mean Difference		0.29			0.18		0.11

Table 1 shows that students who received instruction in Basic Science through the P-L-A-N game strategy achieved a mean gain of 6.11, while those taught using the concept mapping strategy recorded a slightly higher mean gain of 6.22. The difference in

mean gain, favoring the concept mapping group, was 0.11. However, students in the P-L-A-N game group had a lower post-test standard deviation of 4.14, compared to 6.43 observed among students in the concept mapping group.

Hypothesis One

Table 2: ANCOVA Summary of Students' Mean Achievement Scores in Basic Science on Climate Change Concepts Using P-L-A-N Game and Concept Mapping Strategies

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	16.385 ^a	2	8.193	.283	.754
Intercept	5018.736	1	5018.736	173.381	.000
Pre-Test	14.943	1	14.943	.516	.473
Group	1.883	1	1.883	.065	.799
Error	5355.077	185	28.946		
Total	60283.000	188			
Corrected Total	5371.463	187			

a. R Squared = .003 (Adjusted R Squared = -.008)

Table 2 shows that $F(2, 185) = 0.065$ with a p-value of 0.799, which is greater than the 0.05 significance level. This suggests that there is no statistically significant difference in the mean achievement scores of students taught climate change concepts using the P-L-A-N game strategy compared to

those taught with the concept mapping strategy in Basic Science. The R-squared value of 0.003 (0.3%) indicates that only a minimal portion of the variance in students' achievement scores can be attributed to the instructional strategies used, reflecting a very small effect size.

Research Question Two

Table 3: Achievement of Male and Female Students Exposed to Climate Change Concepts in Basic Science Using P-L-A-N Game Instructional Strategy

Gender	Pre-Test			Post-Test		Mean Gain
	N	\bar{x}	SD	\bar{x}	SD	
Male	46	11.24	4.23	16.41	3.79	5.17
Female	51	10.92	2.61	17.86	4.36	6.94
Mean Difference		0.32		1.45		1.77

Table 3 reveal the mean gains of 5.17 and 6.94 for male and female students respectively with a mean gain difference of 1.77 in favour of female students. The standard deviation of 3.79 recorded by male students in

post-test indicates that their achievement scores are more homogenous compare to those of female students with a value of 4.36.

Hypothesis Two

Table 4: ANCOVA Summary of Male and Female Students' Mean Achievement Scores in Basic Science After Instruction on Climate Change Concepts Using the P-L-A-N Game Strategy

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	51.519 ^a	2	25.760	1.517	.225
Intercept	2576.313	1	2576.313	151.690	.000
Pre-Test	.690	1	.690	.041	.841
Gender	50.177	1	50.177	2.954	.089
Error	1596.502	94	16.984		
Total	30262.000	97			
Corrected Total	1648.021	96			

a. R Squared = .031 (Adjusted R Squared = .011)

Table 4 shows that $F(2, 94) = 2.954$ with a p-value of 0.089, which is greater than the 0.05 significance level. This indicates that the P-L-A-N game instructional strategy does not produce a significant difference in the mean achievement scores of male and female students

in Basic Science climate change concepts. The R^2 value of 0.031 (3.10%) suggests that only a small portion of the variance in achievement scores between genders can be explained by the instructional method, reflecting a low effect size.

Research Question Three

Table 5: Achievement Scores of Male and Female Students in Basic Science Climate Change Concepts Taught Using the Concept Mapping Strategy

Gender	Pre-Test			Post-Test		Mean Gain
	N	\bar{x}	SD	\bar{x}	SD	
Male	46	11.22	2.98	17.35	6.64	6.13
Female	45	10.33	3.18	16.64	6.26	6.31
Mean Difference		0.89		0.71		0.18

Table 5 indicates that male students had a mean achievement gain of 6.13, whereas female students recorded a slightly higher mean gain of 6.31. The difference in mean achievement scores between males and females is 0.18, favouring the female students.

Additionally, the female students' post-test scores showed a standard deviation of 6.26, suggesting their results were more consistent compared to the male students, who had a standard deviation of 6.64.

Hypothesis Three

Table 6: ANCOVA Analysis of Male and Female Students' Mean Academic Achievement in Basic Science Climate Change Concepts Using the Concept Mapping Strategy

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	37.263 ^a	2	18.631	.445	.642
Intercept	2400.952	1	2400.952	57.340	.000
Pre-Test	26.009	1	26.009	.621	.433
Gender	16.423	1	16.423	.392	.533
Error	3684.737	88	41.872		
Total	30021.000	91			
Corrected Total	3722.000	90			

a. R Squared = .010 (Adjusted R Squared = -.012)

Table 6 shows that $F(2, 88) = 0.392$ with a p -value of 0.533, which is greater than the 0.05 threshold for significance. This means there is no significant difference in the mean academic achievement between male and female students taught climate change concepts in Basic Science using the concept mapping strategy. The R^2 value of 0.010 (1.0%) suggests that the instructional method accounts for only a small portion of the variance in achievement scores between genders, indicating a low effect size.

Discussion of Findings

The results of the study demonstrated that both the P-L-A-N game and concept mapping instructional strategies enhanced students' average academic achievement scores in climate change concepts within Basic Science. However, the improvement was not statistically significant, indicating no notable difference in the mean achievement scores between students taught using the P-L-A-N game strategy and those taught through concept mapping. This suggests that both instructional approaches effectively improve academic performance in climate change topics, but neither strategy outperforms the other significantly. This outcome aligns with the findings of Anari et al. (2023), who reported no significant difference in learners' mean achievement scores. On the other hand, the result contradicts Ajio et al. (2023), which found that students taught with board games performed significantly better than those taught via traditional methods. The difference in findings may be due to Ajio et al.'s comparison between an interactive, activity-based strategy (board games) and a conventional, less effective teaching approach. The P-L-A-N game's effectiveness can be attributed to its ability to foster a

supportive learning environment, promote interaction, and enhance student motivation. Active engagement and practice enable students to meet learning objectives more easily, while repeated attempts after failure until success are achieved help solidify mastery of the game strategy, thereby boosting academic achievement. Similarly, the concept mapping strategy aids students by simplifying complex, abstract, or unclear concepts and facilitating connections among terms and sub-concepts, which enhances comprehension and ultimately improves academic outcomes.

The study also revealed that female students had slightly higher mean achievement scores than males when taught with the P-L-A-N game strategy; however, the hypothesis testing showed no significant gender difference in achievement. This could be because the P-L-A-N game strategy provided equal opportunities for both male and female students, encouraging active participation from all learners and contributing to comparable improvements across genders. This finding concurs with Anari et al. (2023), who found no significant gender differences in achievement using non-digital game-based learning. In contrast, Bankole (2018) reported that female students significantly outperformed males when taught with card games, and Ojo (2021) found similar results favoring females using the Kahoot game.

Additionally, the research found no significant difference in the mean academic achievement between male and female students taught climate change concepts using the concept mapping strategy. This lack of disparity likely resulted from equal learning opportunities provided to both genders, fostering active engagement in the learning process. This observation aligns with earlier studies by Ajayi and Ogbeba (2017),

Obidike and Onyekwelu (2019), and Baba et al. (2022), all of which found no significant gender differences in academic achievement. It also supports Anari et al. (2023). However, it differs from Bankole (2018), who reported female students outperforming males significantly.

Conclusion

Based on the findings, it can be concluded that both the P-L-A-N game and concept mapping instructional strategies equally enhance students' achievement in climate change concepts within Basic Science. Moreover, these instructional methods are gender-neutral in their effectiveness, supporting academic achievement irrespective of students' gender.

Recommendations

In light of the study's findings, the following recommendations are made:

1. Basic Science educators should incorporate P-L-A-N game and concept mapping strategies to boost students' achievement in climate change topics.
2. Teachers should actively involve students in learning climate change concepts using these instructional approaches to enhance academic performance.
3. Authors and researchers in Basic Science should develop and publish educational materials and studies focusing on the effectiveness of P-L-A-N game and concept mapping strategies in improving students' achievement in climate change concepts.

References

- Achor, E.E., & Musa, J.H. (2022). Use of simulation strategy and students' cognitive load in Basic science. *Journal of the International Centre for Science, Humanities and Education Research*, 5(1), 20-34.
- Adekola, J., Fischbacher-Smith, M., Fischbacher-Smith, D., & Adekola, O. A. (2017). Health risks from environmental degradation in the Niger Delta, Nigeria. *Environment and Planning C: Politics and Space*, 35(2), 334-354.
- Agernor, T., (2016). *Effect of study questions as advance organisers on students' achievement and retention in basic science*. Unpublished M.Ed Dissertation, Benue State University, Makurdi.
- Agogo, P.O., & Nakaa, D.A. (2014). Effect of 5Es constructivist instructional strategy on students' interest in senior secondary genetic in Gwer Local Government Area of Benue State, Nigeria. *Global Journal of Environmental Science and Technology*, 1(2), 15-19.
- Ajayi, O.V., & Ogbeba, J. (2017). Effect of gender on senior secondary chemistry students' achievement in stoichiometry using hands-on activities. *American Journal of Educational Research*, 5(8), 839-842.
- Ajio, C.E., Ode, J.O., & Kpiranyam, F.S. (2023). Game-assisted learning strategy: A strategy for improving upper basic two students' academic achievement and self-esteem in Benue State. *African Journal of Science, Technology and Mathematics Education*, 9(3), 146-151.
- Anari, M. I., Etiubon, R.U., Obi, C. N., Ndidi, A. M., Udofia, T.M., Amba, H.N., Ekon, E.E., Inah, L.I., Arikpo, J.O., & Ogar, E. O. (2023). Comparative effectiveness of non-digital game-based learning and computer simulated instructional methods on academic achievement and retention in Calabar Education Zone, Nigeria. *Advances in Social Sciences and Management*, 1(8), 36-59.
- Anastasiadis, T., Lampropoulos, G., & Siakas, K. (2018). Digital game-based learning and serious games in education. *International Journal of Advanced Scientific Research and Management*, 3(3), 100 -111.
- Anekwe, J.U. (2016). *Effects of constructivist-based instructional model on students' interest and academic achievement in basic technology in Anambra State*. Unpublished Ph.D Thesis. University of Port Harcourt.
- Ani, M. I., Obodo, A.C., Ikwueze, C. C., & Tafi, F.I. (2021). Effect of gender on basic science students' academic achievement in secondary schools. *Unizik Journal of Educational Research and Policy Studies*, 9, 36-43.
- Anita, M. (2015). Effectiveness of smart classroom teaching on the achievement in chemistry of secondary school students. *American International Journal of Research in Humanities, Arts and Social Sciences*, 9(2), 115-120.
- Baba, U. S., Jumma, A.M., & Zachariah, R. (2022). Gender differences on upper basic students' interest and achievement in basic science using the Asei-Pdsi teaching approach in Bauchi Metropolis. *African Journal of Science, Technology and Mathematics Education*, 8(1), 56-61.
- Bankole, I. S. (2018). Deploying card games as tools in learning chemistry concept in Nigerian classrooms. *Journal of Chemical Society of Nigeria*, 43(3), 325-335.
- Benue State Examinations Board (2018-2023). Records and statistics. BSEB Press.
- Broman, K., & Parchmann, I. (2014). Students' application of chemical concepts when solving chemistry problems in different contexts. *Chemistry Education*

- Research and Practice*, 15(4), 516–529. <https://doi.org/10.1039/C4RP00111C>
- Emaikwu, S. O. (2015). *Fundamentals of research methodology and statistics*. Makurdi: Selfers Academy Press.
- Gee, J. P. (2018). *What video games have to teach us about learning and literacy* (2nd ed.). St. Martin's Press.
- Hashim, A., Ababkr, T.E.I.S., & Eljack, N.S.A. (2015). Effects of inquiry based science teaching on Junior Secondary School Students' academic achievements: A case study in Hadejia zonal Education Area of Jigawa State, Nigeria. *SUT Journal of Humanities*, 16 (1), 156 - 169.
- Intergovernmental Panel on Climate Change (IPCC). (2021). *Climate change 2021: The physical science basis. Contribution of Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press. <https://www.ipcc.ch/report/ar6perfro/wg1/>
- International Organisation for Migration -IOM (2024). Nigeria Flood Assessment Report – Benue State. Accessed on 5th December 2024 from <https://dtm.iom.int>
- Kpiranyam, F.S. (2024). Effects of scaffolding-enriched diagnostic assessment techniques on students' test anxiety, emotional intelligence and achievement in biology in Benue State, Nigeria. Unpublished thesis, Rev. Fr. Moses Orshio Adasu University, Makurdi.
- Kpiranyam, F.S., Achor, E.E., & Fakaa, S.G. (2024). Scaling up emotional intelligence and critical thinking of students in biology using concept mapping strategies. *FNAS Journal of Mathematics and Science Education*, 5(4), 92-101.
- Kumar, P., Sahani, J., Rawat, N., Debele, S., Tiwari, A., Emygdio, A.P.M., Abhijith, K.V., Holmes, K., & Pfauisch, S. (2023). Using empirical science education in schools to improve climate change literacy. *Renewable and Sustainable Energy Reviews: Elsevier*, 178, 1-13.
- Muodumogu, C.A., & Gwang, N.J. (2020). Effect of dramatisation strategy on upper basic two students' self-esteem and achievement in reading comprehension in Plateau State. *Journal of Research in Curriculum and Teaching*, 12(1), 11-19.
- National Education Research and Development Council (2024). 9-year Curriculum for Basic Science. NERDC Press.
- Novak, J. D., & Cañas, A. J. (2018). The theory underlying concept maps and how to construct them. *Technical Report IHMC CmapTools 2006-01 Rev 01-2008*, Florida Institute for Human and Machine Cognition.
- Novak, J. D., & Gowin, B. (1984). *Learning how to learn*. Oxford: Cambridge University Press.
- Nwosu, S.N., Etiubon, R.U., & Ofem, I.B. (2022). Effect of activity-based learning on basic
- Obidike, N. D., & Onyekwelu, L. U. (2019). Effects of gender on teaching methods on academic achievement of primary three pupils in basic science in Aguata Local Government Area. *IAA Journal of Social Sciences*, 5(1), 72-80
- Ode, J. O. & Eriba J. O. (2020). Efficacy of Multiple Intelligence Theory-Based Instructional Strategy on Academic Achievement of Basic Science Students in Benue State, Nigeria. *Psychological Report*, 5(8), 1-9.
- Ode, J.O., & Fakaa., G. S. (2023). Evaluation of basic science textbooks used at universal basic education (UBE) schools in Benue state. *Nigeria International Journal of Multidisciplinary Research and Growth Evaluation*, 4(5), 698-703.
- Ojo, A. P. (2021). *Effects of Kahoot game-supported instruction on achievement, retention, and interest in basic technology among secondary school students in Minna, Niger State* (Doctoral dissertation, Federal University of Technology, Minna).
- Okonkwo, I. G., & Samuel, N. N. (2021). Comparative effects of concept mapping and simulation-game teaching strategies on students' interest in environmental concepts in chemistry. *Unizik Journal of STM Education*, 4(1), 76-87.
- Osuafor, A. M. (2014). Enhancing students' academic achievement in Basic Science through the use of reflective instructional strategy. *Journal of Educational and Social Research*, 4(7), 93–99.
- Udu, T.T., Gyuse, E.Y., Samba, R.M.O., & Iortim, S. (2016). Readability characteristics of science and technology students' non cognitive skills in south-south Nigeria. *European Journal of Education and Pedagogy*, 3(5), 67-74.
- Universal Basic Education Commission (UBEC). (2020). *Basic Education Certification Examination (BECE) achievement analysis report*. UBEC Publications.
- Voyer, D., & Voyer, S.D. (2014). Gender differences in Scholastic achievement: A meta analysis. *Psychological Bulletin*, 140(4), 1174 – 1204.