JOURNAL OF SCIENCE TECHNOLOGY AND EDUCATION 14(2), JUNE, 2026
E-ISSN: 3093-0898, PRINT ISSN: 2277-0011; Journal homepage: www.atbufstejoste.com

Effect of Sequence-Chart Teaching Strategy on Secondary School Student Academic Achievement in Nutrient-Cycling in Nature and Pollution In Kano-State-Nigeria

[1]Faith Sadoh, [2]Garba Shuaibu, [3]Hauwa'u Iliyasu
[1&2]Department of Science and Technology Education, Bayero University, Kano. Kano State-Nigeria (BUK),
[3]Department of Science education, Aliko Dangote University of Science and Technology, Wudil

ABSTRACT
This study investigated the effect of Sequence-Chart (SQC) teaching strategy on secondary school students' academic achievement in Nutrient Cycle in Nature and Pollution in Kano State, Nigeria. The study adopted a quasi-experimental design involving pre-test, post-test, equivalent group. Population of the study consists of 11,290 SS11 students and a sample of 340 SSII students were taught using SQC strategy, while another group was taught using conventional teaching method. The instrument for data collection was a validated Nutrient Cycling in Nature and Pollution Achievement Test (NPAT). Data were analyzed using mean, standard deviation, and ANCOVA at 0.05 level of significance. Findings revealed that students taught with SQC strategy had higher mean achievement scores than those taught with the conventional method. ANCOVA results showed a significant difference between the two groups in favour of the experimental group. The study also found significant effects of gender and a significant interaction effect between instructional strategy and gender. The R^2 value indicated that a substantial proportion of variation in students' achievement was explained by the instructional strategy. The study concluded that Sequence-Chart teaching strategy is more effective than conventional teaching method in improving students' academic achievement in Nutrient Cycling in Nature and Pollution. It was recommended that Biology teachers should adopt SQC strategy to enhance students' understanding of complex biological concepts.

ARTICLE INFO
Article History
Received: February, 2026
Received in revised form: March, 2026
Accepted: May, 2026
Published online: June, 2026

KEYWORDS
Sequence-Chart, Academic Achievement, Nutrient-Cycling, Pollution

INTRODUCTION

Education is widely recognized as a fundamental instrument for national development, social transformation, and economic growth (FRN, 2014; UNESCO, 2015). Through education, individuals acquire the knowledge, skills, and values necessary for meaningful participation in society and sustainable development. In the same vein, science education plays a strategic role in fostering innovation, technological advancement, and global competitiveness (OECD, 2018). At the secondary school level, science subjects including Biology are designed to equip learners with scientific literacy and problem-solving skills. Among these subjects, Biology occupies a central position due to its relevance to health, agriculture, environmental sustainability, and biotechnology (Mohammad, Bala, & Bukar, 2021). Despite this importance, effective teaching remains crucial for achieving educational objectives and improving students' learning outcomes in Biology.

Biology is the study of living organisms and their interactions with the environment (Hillis et al., 2020). It serves as a foundation for careers in medicine, nursing, agriculture, pharmacy, and other science-related fields (Salihu et al., 2022). Despite its relevance, students' achievement in Biology remains unsatisfactory, as many concepts are perceived as abstract and difficult (Othuke, 2019; Sadoh & Nwanegbo, 2023). Concepts such

Corresponding author: Faith Sadoh
faithsadoh@gmail.com
Department of Science and Technology Education, Bayero University, Kano. Kano State-Nigeria (BUK).

as nutrient cycling, pollution, genetics, respiration, and photosynthesis are frequently identified as challenging by secondary school students (Abidoye, Abidoye, & Olaide, 2023). Also, poor achievement in Biology has been attributed to factors such as inappropriate teaching methods, inadequate instructional materials, overcrowded classrooms, and students' negative attitudes toward the subject (Nwanegbo, 2022; Isah et al., 2022). Consequently, students often rely on rote memorization rather than meaningful learning, which negatively affects their academic achievement in Biology including nutrient cycling in nature and pollution (Nooraida et al., 2020).

Nutrient Cycling in Nature is the continuous circulation of nutrients such as carb on, nitrogen, oxygen, and water between living organisms and the non-living environment. These nutrients move from the soil, water, and atmosphere into plants and animals and later returned to the environment through processes such as respiration, excretion, decomposition, and decay. Pollution, on the other hand, is explained as the contamination of the environment through the introduction of harmful substances that negatively affect organisms and ecological systems (Ramalingam, 2018).

These concepts are some of the biological concepts that students often find difficult, particularly the aspects concern with diagrammatic representation and explanation of microbial roles such as Lightening, Nitrosomonas and Azotobacter (WAEC, 2019; Abidoye et al., 2023). The topics involves interconnected ecological processes, movement of nutrients within ecosystems, and environmental interactions that require learners to understand sequential relationships among concepts. Because of its abstract nature, many students resort to rote memorization rather than meaningful learning, resulting in poor academic achievement. Studies on ecological concepts in Biology have shown that students perform better when visual and innovative instructional approaches are employed during instruction (Landin & Cozart, 2024).

Sequence Chart Teaching Strategy is one instructional strategy that may enhance students' understanding and achievement of Biological concepts. Sequence chart is a type of graphic organizer that presents information in a logical and stepwise order, enabling learners to organize ideas, identify relationships among concepts, and comprehend processes more effectively (Creately, n.d.). Graphic organizers help learners to visualize concepts and connect new information with prior knowledge, thereby facilitating meaningful learning (Uba et al., (2017). Since Nutrient Cycling in Nature and Pollution involves cycles, stages, and interconnected ecological processes, the use of sequence charts may improve students' comprehension and academic achievement. Studies on graphic organizers, concept maps, mind maps, and advance organizers have demonstrated their effectiveness in improving students' achievement in Biology and other science subject (Akanbi et al., 2021; Aina & Ogunkule, 2022; Velarde, 2019; Kuthuria, (2019); Lynch, 2021).

Academic achievement refers to the extent to which students attain instructional objectives and demonstrate mastery of concepts (Oyovwei, 2019). Academic achievement in nutrient cycling in nature and pollution therefore refers to students' level of performance and understanding of ecological concepts related to the movement and recycling of nutrients within the ecosystem and the pollution of on the environment.

Gender is another important variable frequently considered in science education research. Previous studies on gender and students' achievement in Biology have reported inconsistent findings. While some studies found significant differences between male and female students' achievement, others reported no significant gender influence when innovative instructional strategies were used. For instance, studies involving graphic organizers, concept maps, and advance organizers reported that male and female students benefited similarly from such learner-centered strategies. (Kuthuria, 2019; Odibia, 2021; Oyibo, 2020; Tamunobelema & Jumbo). These inconsistencies indicate the need for further investigation into gender-related

Corresponding author: Faith Sadoh
faithsadoh@gmail.com
Department of Science and Technology Education, Bayero University, Kano. Kano State-Nigeria (BUK).

JOURNAL OF SCIENCE TECHNOLOGY AND EDUCATION 14(2), JUNE, 2026
E-ISSN: 3093-0898, PRINT ISSN: 2277-0011; Journal homepage: www.atbufstejoste.com

outcomes when sequence chart teaching strategy is used in Biology instruction.

Furthermore, the theoretical basis for the use of sequence chart teaching strategy can be linked to David Ausubel's Subsumption Theory, which emphasizes meaningful learning through proper organization of instructional materials. According to the theory, learners understand and retain information better when new knowledge is systematically linked to existing cognitive structures (Ausubel, 1960; Ausubel, 1963). Sequence chart teaching strategy therefore provides structured visual representation that can facilitate comprehension and achievement of biological concepts.

Although several studies have examined graphic organizers and related instructional approaches in science education, no studies appear to have specifically investigated the effect of Sequence Chart Teaching Strategy on secondary school students' academic achievement in Nutrient Cycling in Nature and Pollution, particularly in Kano State, Nigeria based on the literatures available to the researcher at the time of the study. This gap therefore necessitated the present study, which investigated the effect of Sequence Chart Teaching Strategy on secondary school students' academic achievement in Nutrient Cycling in Nature and Pollution in relation to gender.

Objectives of the Study

1. To find out the effect of sequence-chart teaching strategy on students' academic achievement in Nutrient Cycling in Nature and Pollution of senior secondary schools.
2. To examine gender difference among senior secondary school students' academic achievement in Nutrient Cycling in Nature and Pollution when taught with sequence-chart teaching strategy.

Research Questions

1. What is the mean difference in the academic achievements of students taught with sequence-chart, and those taught with conventional method?
2. What is the mean difference in gender academic achievements of students taught nutrient cycling in nature and pollution with sequence-chart, and those taught with conventional teaching method?

Research Hypotheses

H_{01}: There is no significant mean difference in the academic achievement of students taught nutrients cycling in nature and pollution with sequence-chart, and those taught with conventional methods of teaching.

H02: There is no significant mean difference in the academic achievement of male and female students taught nutrients cycling in nature and pollution with sequence-chart, and those taught with conventional methods of teaching

METHODOLOGY

The study adopted a quasi-experimental research design involving a pre-test and post-test non-equivalent control group. Quasi-experimental design was considered appropriate because it allows the researcher to determine cause-and-effect relationships between the independent and dependent variables through treatment and comparison of groups (Thomas, 2023). The population of the study comprised 11,290 SS2 students in all 28 public Senior Secondary Schools in Nassarawa Education Zone, Kano State, Nigeria. SS2 students were selected because Nutrient Cycling in Nature and Pollution are taught at this level. The students were assumed to be relatively homogeneous in age (15–17 years), exposed to the same curriculum, and learning under similar school environments.

The sample consisted of 340 SS2 students drawn from four public secondary schools using intact classes. Intact classes were used because the classes were already organized and could not be randomly restructured. The research instrument used was the Nutrient Cycling in Nature and Pollution Achievement Test (NPAT), developed from WAEC SSCE past questions (2000–2025). The instrument consisted of 30 multiple-choice items with options A–D. Section A contained demographic information such as

Corresponding author: Faith Sadoh
faithsadoh@gmail.com
Department of Science and Technology Education, Bayero University, Kano. Kano State-Nigeria (BUK).

JOURNAL OF SCIENCE TECHNOLOGY AND EDUCATION 14(2), JUNE, 2026
E-ISSN: 3093-0898, PRINT ISSN: 2277-0011; Journal homepage: www.atbufstejoste.com

school, age, class, and gender, while Section B contained the test items. All items were structured to reflect Bloom's taxonomy levels: knowledge, comprehension, application, analysis, synthesis, and evaluation. Each correct response was scored 1 mark, while incorrect responses were scored 0, giving a total maximum score of 30. The instrument was validated by experts in science education and measurement and evaluation. A split-half reliability of 0.75 was obtained using the Spearman's rank-order correlation, indicating acceptable internal consistency for research purposes (Cohen, 1988; Dancey & Reidy, 2004).

Data collected were analyzed using mean, standard deviation, and Analysis of Covariance (ANCOVA) at 0.05 level of significance.

RESULTS

Research Question One:
What is the mean difference in the academic achievements of students taught with sequence chart, and those trained with the conventional method?

Table 1: Mean Difference of the Effect of Sequence Chart on SSII Academic Achievement

Variables	Group	N	$\overline{x}$	SD	M/dff	Remark
Sequence Chart	Experimental	98	21.41	2.94	5.00	Sequence Chart Affect Students
	Control	85	16.41	3.31		Achievement

Table 4.1 shows the academic achievement of students taught with sequence chart ($\overline{x} = 21.41$, SD 2.94), as the standard deviation shows the students' academic achievement were closely related. This is also the same in the control group ($\overline{x} = 16.41$, SD = 3.31). The mean difference between the academic achievement of those taught with sequence chart and those taught with conventional method is 5.00 in favour of those taught with sequence. Thus, indicating that sequence chart affects the students' academic achievement.

H01: There is no significant mean difference in the academic achievement of students taught nutrients cycling in nature and pollution with sequence chart teaching strategies, and those taught with conventional methods of teaching.

Table 2: ANCOVA Result for SSII Academic Achievement taught with Sequence Chart (SC)

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	1136.474[a]	2	568.237	58.045	.000
Intercept	5608.585	1	5608.585	572.913	.000
SC_Pre_test	.135	1	.135	.014	.907
Group	998.333	1	998.333	101.979	.000
Error	1762.127	180	9.790		
Total	69571.000	183			
Corrected Total	2898.601	182			

a. R Squared = .392 (Adjusted R Squared = .385)
Dependent Variable: Sequence Chart _Post-test (SC)

Table 2 presents the results of an Analysis of Covariance (ANCOVA) conducted to determine the effect of sequence chart on students' posttest scores while controlling for their pretest performance (SC_Pretest). The corrected model was statistically significant, $F(2,180) = 58.05, p < 0.001$, indicating that the combined effects of the covariate and group significantly explained variance in students' posttest scores. The model accounted for 39.2% of the variance in the dependent variable ($R^2 =$

Corresponding author: Faith Sadoh
faithsadoh@gmail.com
Department of Science and Technology Education, Bayero University, Kano. Kano State-Nigeria (BUK).

JOURNAL OF SCIENCE TECHNOLOGY AND EDUCATION 14(2), JUNE, 2026
E-ISSN: 3093-0898, PRINT ISSN: 2277-0011; Journal homepage: www.atbufstejoste.com

$0.392; Adjusted R^2 = 0.385$), demonstrating a moderate explanatory power.

The covariate, SC_Pretest, did not have a statistically significant effect on students' posttest scores, $F(1,180) = 0.01, p = 0.907$. This result suggests that students' pretest scores did not significantly influence their posttest performance after controlling for group differences. In contrast, the group effect was statistically significant, $F(1,180) = 101.98, p < 0.001$. This finding indicates that there was a significant difference in posttest scores between the experimental and control groups after adjusting for pretest scores. Thus, instructional grouping had a substantial effect on students' outcomes. The intercept was also statistically significant, $F(1,180) = 572.91, p < 0.001$, showing that the adjusted mean posttest score differed significantly from zero when the predictors were held constant.

In summary, the ANCOVA results demonstrate that while pretest scores did not significantly predict posttest achievement, the sequence chart instructional strategy had a strong and statistically significant effect on students' posttest outcomes. This suggests that the instructional strategy associated with the experimental group was effective in improving students' performance relative to the control group.

Research Question Two:

What is the mean difference in gender academic achievements of students taught nutrient cycling in nature and pollution with sequence chart, and those taught with conventional teaching method?

Table 3: Mean Difference between Male and Female Students' Academic Achievement

Gender	Group	N	$\bar{x}$	SD	M/diff	Remark
Male SC	experimental	39	21.41	2.70		In favour of SQC
	control	34	13.88	2.25	7.53	
Female SC	experimental	59	21.41	3.11		In favour of SQC
	control	51	18.10	2.80	3.31	

Table 3 shows that male students in the experimental group recorded a higher mean academic achievement score (*M* = 21.41, *SD* = 2.70) compared to their counterparts in the control group, who obtained a mean score of 13.88 (*SD* = 2.25). The mean difference of 7.53 indicates a substantial improvement in academic achievement among male students exposed to the Sequence Chart strategy. Similarly, female students in the experimental group achieved a higher mean score (*M* = 21.41, *SD* = 3.11) than those in the control group, who recorded a mean score of 18.10 (*SD* = 2.80). The mean difference of **3.31** suggests that the Sequence Chart strategy also enhanced academic achievement among female students, although the magnitude of improvement was greater for males.

By implication, the findings indicate that SQC is effective in improving students' academic achievement across gender. However, the magnitude of improvement was consistently higher among male students than female students for Sequence Chart strategy. This suggests a possible interaction between gender and instructional strategy on students' academic achievement, with male students benefiting more strongly from the interventions.

$H0_2$: There is no significant mean difference in the academic achievement of male and female students taught nutrients cycling in nature and pollution with sequence chart teaching strategies, and those taught with conventional methods of teaching.

Table 4: ANCOVA for male and female academic achievement SQC

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	1503.995[a]	4	375.999	47.990	.000

Corresponding author: Faith Sadoh
faithsadoh@gmail.com
Department of Science and Technology Education, Bayero University, Kano. Kano State-Nigeria (BUK).

JOURNAL OF SCIENCE TECHNOLOGY AND EDUCATION 14(2), JUNE, 2026
E-ISSN: 3093-0898, PRINT ISSN: 2277-0011; Journal homepage: www.atbufstejoste.com

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Intercept	3555.718	1	3555.718	453.833	.000
SC_Pre_test	5.106	1	5.106	.652	.421
Group	1111.412	1	1111.412	141.855	.000
GENDER	135.705	1	135.705	17.321	.000
Group * Gender	171.598	1	171.598	21.902	.000
Error	1394.606	178	7.835		
Total	69571.000	183			
Corrected Total	2898.601	182			

a. R Squared = .519 (Adjusted R Squared = .508); Dependent Variable: SC_Post_test

A two-way analysis of covariance (ANCOVA) was conducted to examine the effects of group and gender on SC post-test scores while controlling for SC pre-test scores. The overall model was significant, $F(4,178) = 47.990, p < 0.001$, accounting for 51.9% of the variance in SC post-test scores. The covariate, SC pre-test score, was not statistically significant, $F(1,178) = 0.652, p = 0.421$. There was a significant main effect of group, $F(1,178) = 141.855, p < 0.001$, and gender, $F(1,178) = 17.321, p < 0.001$. In addition, the interaction between group and gender was significant, $F(1,178) = 21.902, p < 0.001$, indicating that the effect of group on SC post-test scores varied by gender.

DISCUSSION OF FINDINGS

The findings of Research Question one and two revealed that students taught Nutrient Cycling in Nature and Pollution using the sequence-chart (SQC) teaching strategy had higher academic achievement than those taught using the conventional The ANCOVA result further confirmed that this difference was statistically significant, leading to the rejection of the null hypothesis. This finding is consistent with recent empirical studies on visual and graphic organizer-based instructional strategies. For example, Ugwoke and Ude (2022); Hasanah and Adlini (2023) reported that students taught Biology using mind mapping strategies significantly outperformed those taught with conventional methods in secondary schools.

In addition, Onah, Anamezie, and Nnadi (2022) also reported that mind map graphic organizers significantly improved students' academic performance in physics, supporting the effectiveness of structured visual learning tools. However, Gaven et al. (2022) found that although students' performance improved during learning activities, mind mapping did not produce significantly higher achievement. Also, Laleye (2022) reported that although graphic advance organizers improved students' achievement in basic science the level of improvement was not significantly higher under all instructional conditions.

The findings of table three and four revealed that male and female students taught Nutrient Cycling in Nature and Pollution using the sequence-chart (SQC) teaching strategy performed significantly better than those taught using the conventional method. The ANCOVA result indicated a significant difference in favour of the experimental group. The study also revealed a significant effect of gender on academic achievement, with male students slightly outperforming female students. This finding aligns with study of Opara and Ayanarillaye (2020); Birabel and Brown (2020); Oyibo (2020) who found significant difference of instructional strategies on male and female students, with the male student performing higher than the female students.

However, the study contradicts the studies of Ugwoke and Ude (2022)) who found that female students outperformed the male counterpart when taught with instructional strategies. Anaekwe and Nnaka (2020) reported that female students performed better under collaborative learning stratagies in Biology. The

Corresponding author: Faith Sadoh
faithsadoh@gmail.com
Department of Science and Technology Education, Bayero University, Kano. Kano State-Nigeria (BUK).

present finding therefore suggest that while SQC is effective for both male and female students, the degree of effectiveness may vary slightly across gender.

CONCLUSION

The study concluded that sequence-chart teaching strategy is more effective than conventional teaching method in improving students' academic achievement in nutrient cycling in nature and pollution. It also enhances meaningful learning and cognitive organization of biological concepts.

RECOMMENDATIONS

Based on the findings, the following were recommended that Biology teachers should adopt sequence-chart strategy in teaching complex concepts and teachers should be trained on the use of SQC and other visual learning strategies. Also, Curriculum planners should integrate graphic organizers such as sequence-chart into Biology curriculum.

REFERENCES

Abidoye, O.F., Abidoye, A.A. & Olaide, O. (2023). The Effect of Biology Teaching Materials on the Academic Performance of Senior Secondary School Students in Ilorin West, Ilorin, Kwara State. *International journal of education and research 2(4): 142-150.*

Aina, O. M., & Ogunkunle, R. A. (2021). Effect of Concept Mapping Strategy on Senior Secondary School Students' Achievement in Biology in Ondo State, Nigeria. *International Journal of Education and Evaluation, 7(2), 109-119.*

Akanbi, A. O., Olayinka, Y. W., Omosewo, E. O., & Mohammed, R. E. (2021). Effect of Mind Mapping Instructional Strategy on Students' Retention in Physics in Senior Secondary Schools. *Anatolian Journal of Education, 6(1), 189-198.*

Anaekwe, M.C, & Nnaka, C.V.(2020). Gender differences in the learning styles of high and low achievers in biology: Implications for Nigerian education system. *Social Science and Education Research Review,* 7(2), 172-188.

Ausubel, D.P. (1961). *In Defense of Verbal Learning. Education Theory 11(1):15-25. https://doi.org/10.111/j.1741-5446.1961.tb00038.X*

Ausubel, D.P. (1968). *Educational psychology: A cognitive view*. New York: Rinehart and Winston.

Ausubel, D.P.(1960). The use of Advance Organizers in the Learning and Retention of Meaningful Verbal Material. *Journal of Educational Psychology*,51(5):267-272

Birabil, S.T., & Brown, C.N.(2020). Effect of Concept-Mapping Technique on Students' Academic Performance in Social Studies in Rivers State, Nigeria. *European Journal of Research in Social Sciences*,8(1),84-9.

creately, (n.d.). Sequence chart/ Sequence graphic organizer. Creately. https://share.google/NOYyv0kOFYryyzqAt

Federal Republic of Nigeria. (2014). National policy on education (6th ed,). NERDC Press.

Gaven, N., Doignon-Camus, N., Chaillou, A.C, Zeitler, A., & Popa-Roch, M.(2022).Effectiveness of mind mapping for learning in a real educational setting.*Journal of Experimental Education* 90(1), 45-55

Hasanah, U., & Adlini, M.N.(2022). Improving student biology learning outcomes through guided inquiry assisted mind mapping. BIO-INOVED: *Jurnal Biologi-Inovasi Pendidikan,*4(3)

Hillis, D.M., Heller, H.C, Hacker, S. D., Laskowski, M.J. & Sadava, D.E. (2020). *Studying life: the science of Biology (12thed).*

Isah, J.F., Hamza, M.B., Iliayasu, H., & Salihu, A.F. (2022). Science Process Skills Acquisitions and its Influence on Academic Achievement of Biology Students in Dala Zone, Kano State. *Wudil Journal of Science and Technology Education (WUJOSTEC) 4(1):121-129*

Kuthuria, S.(2019). Graphic Organizers: The Use of Mind Maps and Concept Maps for Indexing of Concepts in Science Education in Delhi, India. *Journal of Teacher Education and Research*,14(2),17-23.

Laleye, A.M.(2022). A comparative study of the effect of gamification and advance organizers on students' performance in Basic science in Ondo State. Nigeria.*International Academic Journal of Education & Lityerature,* 3(1), 1-7. https://doi.org/10.47310/iajel.202.v03i01.019

Landin, J.M., & Cozart, A.J.(2024). Redesign of a life cycle figure improves student conceptions

Corresponding author: Faith Sadoh
faithsadoh@gmail.com
Department of Science and Technology Education, Bayero University, Kano. Kano State-Nigeria (BUK).

of ecology and evolution. *Education Science,* 14(4), 403. https://doi.org/10.3390/educsi14040403

Lynch, A. (2021). Main Idea and Details Graphic Organizer. https://www.twinkl.co.uk/resource/amp/us

Mohammad, A.I, Bala, S.S. & Bukar, M.F.(2021). Effect of Collaborative Learning Strategies on Students' Academic Achievement and Gender in Biology among Senior Secondary School Students in Kano Municipal: Implication for STEAM Education. *Bayero Journal of Science, Technology and Mathematics Education (BAJOSTME), 2(1):85-93.*

Nooraida, S. M., Ahmad, M. N., Kelvineh, K., & Abdullah, A. (2020). The Effects of 5E in Enhancing the Understanding of Meiosis Concept. *International Journal of Evaluation and Research in Education (IJERE)* (9) 1: 129-139.

Nwanegbo, P.C.B. (2022). Assessing Teachers' Belief as a Predictor to Interest and Performance in Biology among Secondary School Students in Nassarawa Zone, Kano-Nigeria. *Wudil Journal of Science and Technology Education (WUJOSTEC) 4(1):43-50.*

Odiba, C.O.(2021). Effects of Concept Mapping and Problem Solving Strategies on Understanding of Nature of Science among Secondary School Biology Student Zaria, Nigeria. *Journal of Science Technology and Education. 9(4): 109-114.* www.atbuftejoste.com

OECD (2018), Education at a Glance 2018: OECD Indicators, OECD Publishing, https://doi,org/10.1787/eag-2018-en

Onah, K.T., Anamezie, R.C., & Nnadi, F.O (2022).Effect of mind mapping teaching approach on students' academic achievement in physics concepts of motion and kinematics.*Greener Journal of Educational Research,* 12(1), 31-40

Opara, M.F., & Ayanarillaye, L. (2020).Graphic Organizers and Students' Achievement in Physics and Chemistry: Integrating Technology in Science Classroom. *Global Scientific Journals,* 8(3), 247-259.

Othuke, A.A. (2019). The Role of Biology Education in National Development. Education Research Portal.

Oyibo, E.G. (2020). Effects of Concept Mapping on Students Achievement and Interest in Biology in Nsukka Local Government Area, Enugu State (Master's Thesis). University of Nsukka, Nigeria.

Oyovwi, E.O. (2019). Enhancing Biology Students' Academic Achievement and Attitude through Self-Regulated Learning Strategy in Senior Secondary Schools in Delta Central Senatorial District: *Journal of Educational and Social Research* 9(4); 1-8.

Ramalingam, S.T.(2018). *Modern Biology, S S Science Series*. Pg. 1-3 New Edition, AFP.

Sadoh, F., & Nwanegbo, P. C. B.(2023). Biology Education amidst National Challenges: implication to Teaching and Learning. *ATBU Journal of Science, Technology and Education. 10(4), 350-365.* Atbuftejoste.com.ng.

Salihu, A.F.,Iliyasu, H., Hamza, Z. & Jibril, F. (2022). Effect of Discovery Method of Teaching Biology among Public and Private Secondary School Students in Gwale Zone, Kano State. *Wudil Journal of Science and Technology Education (WUJOSTEC) 4(1): 113-120.*

Uba, E., Oteikwu, E.A., Aikpitanyi, S.O., & Abiodun-Eniayekan, E, (2017). A research based evidence of the effect of graphic organizers on the understanding of prose fiction in ESL classroom. *SAGA Open,*7(2). 1-10. https://doi.org/10.1177/2158244017709506

Ugwoke, A.O. & Ude,V.C.(2022).Effect of Concept Mapping Instructional Strategy on Senior Secondary School Students' Achievement in Biology in Enugu Education Zone, Enugu State, Nigeria. *Asian Journal of Education and Social Studies*, 26(1),25-35.

UNESCO, (2015). Rethinking education: Towards a global common good? Paris: UNESCO Publishing.

Valarde, O. (2019). 15 Graphic Organizers and how they help visualize Ideas. https://visme.co. Retrieved January 31, 2023.

Corresponding author: Faith Sadoh
faithsadoh@gmail.com
Department of Science and Technology Education, Bayero University, Kano. Kano State-Nigeria (BUK).