ISSN: 5431 - 5671
Volume 9, Number 2, 2025
International Journal of Innovations in Science Education

COMPARATIVE EFFECTS OF JIGSAW AND CONCEPT-MAPPING PEDAGOGIES ON STUDENTS ACHIEVEMENT IN BIOLOGY IN TARABA STATE, NIGERIA

[1]Maikano, Stanley (PhD) & [2]Simon, Kauna
[1&2]Department of Science Education, Taraba State University, Jalingo, Nigeria

Email:Stanmaikano@gmail.com, Kauna2019simon@gmail.com

ABSTRACT

This study investigated the comparative effects of jigsaw and concept-mapping pedagogies on students' achievement in Biology in Jalingo Education Zone, Taraba State, Nigeria. Three research questions and three hypotheses guided the study. The study adopted a quasi-experimental design of pre-test, post-test, non-equivalent group. The study involved two experimental groups (EGs); EG1 was exposed to Jigsaw pedagogy and EG2 was to Concept-mapping pedagogy. The population for the study was 5,361 from the 44 co-educational public schools in the zone students. The sample size of 135 Biology students comprising of 70 boys and 65 girls was obtained through purposive sampling. Instrument used for data collection was Biology Achievement Test (BAT). BAT was face and content validated by two experts from Science Education Department and one expert from Measurement and Evaluation unit all from the Faculty of Education Taraba State University, Jalingo. The reliability index of BAT was found to be 0.87 using Kuder Richardson 20 formula after a pilot test was conducted. Mean and standard deviation were used to answer all research questions while Analysis of Covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance. Findings revealed that concept-mapping group significantly achieved more than the jigsaw group ($p<0.05$). Also, no significant gender difference in achievement of students taught biological concepts using jigsaw pedagogy ($p>0.05$). Similarly, both male and female had the same level of achievement when taught biological concept using concept-mapping ($p>0.05$). It was concluded that concept-mapping enhances students' achievement in biology better than jigsaw, especially, in the teaching of nervous system. Therefore, the study recommended that; concept-mapping pedagogy should be used in teaching Biology, especially nervous system at the secondary school level.

Keywords: Jigsaw, concept mapping, achievement and gender.

INTRODUCTION

For any nation to be regarded as developed, it is as a result of the nation's advancement in science and technology. Science today is so vital towards promoting development prompting Famuwagun and Ojobola (2021) to point out that it is such an indispensable tool that no nation, either developed or developing, wishing to progress in the socio-economic spheres will afford to relegate its learning in schools. Science is a part of the Nigeria Education Curriculum taught at all levels: at the Basic level of education, it is taught as Basic Science, where the pupils are taught the rudiments of science. At the secondary level, science subjects are taught in the form of Biology, Chemistry, Physics amongst others. Badri et al. (2020) viewed science as an area of learning in the world today through which the development and progress of any nation are based. It is for this reason that science is taught in all the aforementioned levels of education in Nigeria and Biology is one of the science subjects that could bring about this much-needed development.

Biology is a science subject first introduced to the students at the secondary level of education. Joshi et al. (2024) defined Biology as the study of living things and their vital processes. Biology is the study of what is or was once alive, be it plant or animal. The knowledge gotten from Biology helps in checking environmental degradation such as desertification, erosion, pollution, global warming, amongst others. Biology is important because it helps in understanding how living things work and how they function and interact on multiple levels. Advances in biology have helped

scientists do things such as develop better medicines and treatments for diseases, understand how a changing environment might affect plants and animals, produce enough food for a growing human population and predict how eating new food or sticking to an exercise regimen might affect our bodies. Ibrahim et al. (2018) stated that biology helps in understanding our bodies (from genetics to physiology), what we eat, the air we breathe; it also helps us to prevent, cure and even eliminate diseases. These benefits of Biology have made it necessary for the Nigerian child to learn the subject at the secondary level especially if the child intends to pursue a career in biology especially at the tertiary level. The objectives of teaching biology at the secondary level includes; meaningful and relevant knowledge in biology, ability to apply scientific knowledge to everyday life, and reasonable and functional scientific attitudes. The indicator that could show students have acquired these objectives and have found biology to be relevant in solving biological problems is students' academic achievement. A low achievement indicates that the objectives have not been attained whereas high achievement depicts that the objectives have been attained.

Academic achievement is an important goal in the process of teaching and learning. Students' academic achievement refers to their educational accomplishment at school, and it is usually characterized by a score or percentage Ajayi (2017). Higher scores indicate better academic achievement. One undeniable importance of academic achievement is that it is a great determinant of students' placement in the tertiary institutions. Their achievements influence the academic discipline they get and subsequently, their future career. For students who wish to pursue a career in biology, they must pass biology at the secondary level with a minimum of 'C' grade (Credit). However, given this value and importance attached to students' academic achievement, in Taraba State, there is an observed persistent low achievement of students evident in their past West African Senior School Certificate Examination (WASSCE) result where regularly, less than 50% of the students obtain the minimum 'C' grade in Biology .This gross underachievement of students could be attributed to teachers' choice of pedagogical strategies especially, given the fact that these strategies' effectiveness could be dependent on the specific concept. Strategies such as guided discovery, jigsaw pedagogy and concept mapping could all have bearing on students' achievement.

It is no gainsaying that in a typical Nigerian science classroom, the traditional lecture method still predominates. This method is teacher-centered and the learners are not actively engaged in meaningful hands-on activities. The learners only remain passive listeners struggling to memorize the concepts taught without actually understanding them. The resultant effect is poor learning, poor perception of the concepts taught and poor academic achievement. For the purpose of this study, nervous system (nervous coordination and sense organs) in biology was taught using jigsaw and concept-mapping pedagogical strategies. Jigsaw is a type of cooperative teaching strategy, there are varieties of these pedagogical strategy from which a teacher can select for facilitating learning and students' achievement. Examples include, Think-Pair-Share, Think-Pair-Solo, Numbered Heads Together, Coop-Coop, Pantomime-A-Tale, Round-Robin brainstorming, Teams-Games-Tournaments and Student Teams Achievement Division amongst others. This study used Jigsaw as one of cooperative pedagogical strategy to compare with concept-mapping pedagogy

Jigsaw instructional strategy was developed by Elliot and was based on the idea that cooperation develops each individual, and each individual can reach a goal only if all other individuals in the group reach their goals (as cited in Mari et al, 2015). Daiko et al. (2023) stated that in Jigsaw cooperative teaching strategy, the classes are broken into groups of 4-6 members and assigned tasks which are only parts of the lesson to be taught for the groups ('home groups') to work on. Thereafter, each student from every home group is assigned a portion of the material; then the home groups' members will disengage from the group and join other teams and form expert groups. Whereas in the expert groups, the students study intensively their particular material to ensure that they understand it well and prepare it for peer tutoring. Lestik et al, as cited in Daiko et al. (2023) asserted that after this, each student returns to his or her respective home group he or she teaches his assigned material to the rest of his or her group and learns the other sub-topics from his/her peers in the group. For example, the concept; Nervous co-ordination is been classified based on the

behavioral objective, then assigned to each team, the various team members reads their section. Then the students return to their teams and take turns teaching the students about their sections. Different studies have been conducted on jigsaw in different location, under different conditions and different findings were gotten from the studies. For instance, Ukeh and Anih (2023) found out from their study that students who were taught data processing using jigsaw instructional strategy recorded better achievement than their counterparts who were taught with the lecture teaching method. Sometimes, one way students can learn concepts apart from learning on their own is to listen carefully to their segments. They are motivated to support and show interest in one another's work. This jigsaw pedagogy can bring children of different races and abilities together. According to Dat (2016) jigsaw learning is based on the perspective that each student will first become an expert in a small part of the whole learning material, and then teach other students about this part of the material. Similarly, in his study it was found that students in the jigsaw group significantly achieved better than those in the lecture method group.

Concept mapping have gained widespread acceptance (evident in the number of past studies that have been conducted to establish its effectiveness). For example, Ogonnaya et al. (2016) investigated the effects of concept mapping on students' achievement in basic science and findings from their study revealed that concept mapping fosters students' achievement in basic science than conventional method. It boosts the achievement of both male and female students in the subject. Adeniran et al. (2018) defined concept mapping as a technique of visually organization of structure of information, concepts and their relationship. It is seen as a pedagogy where content that are vast are broken down into a more meaningful and manageable junk using lines and arrow. According to Yunus as cited in Awodun (2017) concept mapping is a teaching and learning strategy that established a bridge between how people learn knowledge and sensible learning. Concept Mapping according to Novak et al, as cited in Ogonnaya et al.(2016) is a schematic device for representing a set of concept meaning embedded in a hierarchical diagram that illustrate the interconnections between, within and among concepts. A concept map is the end result or diagrammatical representation of concepts while concept mapping is the strategy or the process towards arriving at that map. Concept Mapping is a pedagogy that helps learners to be able to use lines and arrows to break down concepts that are vast into a more meaningful learning and help learners learn independently. It helps develop in the students the ability to think logically by revealing connections and helping learners see how individual ideas or concepts form a larger idea. This strategy as observed by Novak serves as both learning tool as well as evaluation tools which encourage the students to use meaningful mode-learning patterns as cited in Tarim et al. (2022). Despite the effort of science educators such as Danjuma (2017) towards finding suitable pedagogical strategy for effective teaching in secondary schools, the achievement of the students in biology during external examinations is still low.

Gender is commonly associated with students' academic achievement in sciences. Owoyemi et al. (2021) pointed out that gender is a set of socially influenced roles and associations, human traits, attitude among others that differentiate both sexes. Gender issue in science education has attracted the attention of many researchers. In science classroom, gender bias occurs when the teacher gives preference by favouring more of the male students than the female students. According to Filgona cited in Danjuma et al. (2024) gender is the range of physical, biological, mental and behavioral characteristics differentiating between male and female. Studies on gender as it affects students' academic achievement in biology are inconclusive, hence, needs further investigations. Science learning sometimes could suffer from gender stereotype. The results of this, most times, as documented by Cuomo et al, as cited in Daiko (2023) is resistance and lack of self-confidence (typical in girls) or in overestimation and excess of desire to be in the limelight typical in boys. Gender is used to analyse the responsibilities of men and women in the society. Science teachers are often encouraged to provide equal classroom opportunities to both male and female students. This is because their teaching strategies could interact with gender to impact students' achievement.

Students' achievement in Biology is an interesting learning outcome because Biology is a crucial science subject that sets the pace for scientific literacy. However, students' achievement in Biology, especially in Jalingo Education Zone, Taraba State, Nigeria has not attained the heights .This low achievement is connected to students' poor achievement in some difficult topics in biology which was found according to Chukwuemeka et al. (2019) to include nervous co-ordination, sense organs and sensory receptors. Apparently, teacher's choice of pedagogical strategies is crucial towards solving this problem of low achievement in biology. A number of pedagogical strategies have emerged which has been used in teaching different concepts in biology; however these strategies are topic or concept-specific. Concept-specificity means that a strategy which was found to be effective in teaching a given concept may not be effective in teaching another concept. It is in the light of this phenomenon that the effectiveness of two strategies was compared on concepts to determine which of them was more effective. The study compared effects of jigsaw and concept mapping pedagogies on the academic achievement of students in biology particularly in Jalingo Education Zone of Taraba State, Nigeria.

PURPOSE OF THE STUDY

The study sought to:

1. Determine the achievement of students taught biological concepts using Jigsaw and concept-mapping pedagogies.
2. Find out the achievement of male and female students taught biological concepts using Jigsaw pedagogy compare to their counterparts taught the same concept using concept-mapping pedagogy.

RESEARCH QUESTIONS

1. What is the mean achievement score of students taught biological concepts using Jigsaw and concept-mapping pedagogies?
2. What is the mean achievement score of male and female students taught biological concepts using jigsaw pedagogy compare to their counterpart taught the same concepts using concept-mapping pedagogy?

HYPOTHESES

H_{O1}: There is no significant difference in the mean achievement scores of students taught biological concepts using Jigsaw and concept-mapping pedagogies

H_{O2}: There is no significant difference in the mean achievement scores of male and female students taught biological concepts using Jigsaw pedagogy compare to their counterpart taught the same concepts using concept-mapping pedagogy.

METHODOLOGY

This study adopted a pre-test, post-test, non-equivalent group quasi-experimental research design. This is because intact classes were used to establish the effects of jigsaw and concept-mapping pedagogies on students' achievement. The population of the study consisted of all the students taking Biology in secondary school two (SS 2) in the 44 public co-educational secondary schools in Jalingo Education Zone of Taraba State, Nigeria, which is 5,361, out of which the sample size of 135 students were chosen using purposive sampling, of which 70 were boys and 65 were girls. The content scope for this study was the Nervous coordination and sense organs. The study was conducted in the 2023/2024 academic session. The two sampled schools were allocated to experimental group I and experimental group II using simple random sampling. EG1 were exposed to jigsaw pedagogy while WG2 were exposed to concept-mapping pedagogy.

The instrument used for the collection of data is the Biology Achievement Test (BAT). The BAT was a multiple-choice test which contains 40 items . The BAT was face and content validated by experts in Science Education and Measurement and Evaluation from Faculty of Education, Taraba

State University. A reliability index of 0.87 was obtained for BAT using Kuder Richardson 20 formula. Students in experimental group 1 and 2 were both given the instrument as pre-test before the commencement of treatment by the trained research assistants who were the Biology teachers of the sampled schools. Thereafter, students in experimental group 1 were taught using jigsaw pedagogy while students in experimental group 2 were taught using concept-mapping pedagogy. Treatment lasted for four weeks and BAT was given to the students to collect post-test data. Mean and standard deviation were used to answer research questions raised while Analysis of Covariance (ANCOVA) was used to test all the hypotheses formulated at 0.05 level of significance.

RESULTS

Research question 1: What is the mean achievement score of students taught biological concepts using Jigsaw and concept-mapping pedagogies?

Table 1

Mean and standard deviation of students' mean achievement score by pedagogies

Pedagogical Strategy		PreBAT	PostBAT	Mean gain
	Mean	10.14	30.24	20.10
Jigsaw	N	70	70	
	Std. Deviation	2.48	0.91	
	Mean	9.77	34.49	24.72
Concept-mapping	N	65	65	
	Std. Deviation	3.00	1.79	
Difference				4.62

The table above shows that at pre-test, students taught biological concepts through jigsaw strategy had a mean achievement score of 10.14 with standard deviation of 2.48. At post-test, the students had a mean achievement of 30.24 and a standard deviation of 0.91. Students in this group showed a mean gain of 20.10. Students in the concept-mapping group had a mean achievement score of 9.77 and standard deviation of 3.00 at pre-test but this figure rose to 34.49 and standard deviation of 1.74 at post-test. This indicates a mean gain of 24.72.

Research question 2: What is the mean achievement score of male and female students taught biological concepts using jigsaw pedagogy compare to their counterpart taught the same concepts using concept-mapping pedagogy?

Table 2a.

Mean and standard deviation of the mean achievement score of students in the Jigsaw pedagogy by gender

Gender		preBAT	postBAT	mean gain
	Mean	9.95	30.34	20.39
Male	N	41	41	
	Std. Deviation	2.78	0.83	
	Mean	10.41	30.10	19.69
Female	N	29	29	
	Std. Deviation	1.97	1.01	
Difference				0.70

The table above shows that at pre-test, male students who were taught biology through jigsaw strategy had a mean achievement score of 9.95, standard deviation of 2.78 and at post-test, the mean achievement score increased to 30.34, standard deviation of 0.83. This indicates mean gain of 20.39. Furthermore, at pre-test, female students who were taught biology through jigsaw

strategy had a mean achievement score of 10.41, standard deviation of 1.97 and at post-test, the mean achievement increased to 30.10, standard deviation of 1.01. This indicates mean gain of 19.69.

Table 2b
Mean and standard deviation of the mean achievement score of students in the concept-mapping pedagogy by gender

Gender		preBAT	postBAT	mean gain
	Mean	9.83	34.17	24.34
Male	N	24	41	
	Std. Deviation	3.04	1.71	
	Mean	9.73	34.68	24.95
Female	N	41	29	
	Std. Deviation	2.99	1.82	
Difference				0.61

The table above shows that at pre-test, male students who were taught biology through concept mapping strategy had a mean achievement score of 9.83, standard deviation of 3.04 and at post-test, the mean achievement score increased to 34.17, standard deviation of 1.71. This indicates mean gain of 24.34. Furthermore, at pre-test, female students who were taught biology through concept mapping strategy had a mean achievement score of 9.73, standard deviation of 2.99 and at post-test, the mean achievement increased to 34.68, standard deviation of 1.82. This indicates mean gain of 24.95.

Null Hypothesis One: There is no significant difference in the mean achievement scores of students taught biological concepts using jigsaw and concept-mapping pedagogies.

Table 3
ANCOVA result of mean achievement score of students taught biological concepts using jigsaw and concept-mapping pedagogies.
Dependent Variable: PostBAT

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	608.652a	2	304.326	153.864	.000
Intercept	9852.764	1	9852.764	4981.461	.000
PreBAT	.037	1	.037	.019	.892
Strategies	**605.115**	**1**	**605.115**	**305.940**	**.000**
Error	261.081	132	1.978		
Total	141617.000	135			
Corrected Total	869.733	134			

Table above shows that F (1,132) = 305.940; p = 0.000 < 0.05. This means that the result of test of significance is lower than the benchmark 0.05; consequently, the null hypothesis is rejected. This implies that there is a significant difference in the mean achievement score of students taught biological concepts using cooperative and concept-mapping pedagogical strategies.
Null Hypothesis two: There is no significant difference in the mean achievement scores of male and female students taught biological concepts using jigsaw pedagogy compare to their counterpart taught the same concepts using concept-mapping pedagogy.

Table 4a.
ANCOVA result of achievement scores of male and female students taught biological concepts using jigsaw pedagogy.
Dependent variable: jpostBAT

Source	**Type III Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig.**
Corrected Model	2.646[a]	2	1.323	1.635	.203
Intercept	3633.850	1	3633.850	4489.916	.000
JpreBAT	1.684	1	1.684	2.080	.154
JGender	**.733**	**1**	**.733**	**.906**	**.345**
Error	54.225	67	.809		
Total	64081.000	70			
Corrected Total	56.871	69			

Table above shows that F (1, 67) = 0.906; p = 0.345 > 0.05. This means that the result of test of significance is higher than the benchmark 0.05; consequently, the null hypothesis is accepted. This implies that there is no significant difference in the mean achievement score of male and female students taught biological concepts using jigsaw pedagogical strategy

Table 4b.
ANCOVA result of mean achievement scores of male and female students taught biological concepts using concept-mapping pedagogy
Dependent variable: cmpostBAT

Source	**Type III Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig.**
Corrected Model	4.969a	2	2.484	.773	.466
Intercept	6334.087	1	6334.087	1970.685	.000
CMpreBAT	.934	1	.934	.291	.592
CMGender	**4.098**	**1**	**4.098**	**1.275**	**.263**
Error	199.278	62	3.214		
Total	77536.000	65			
Corrected Total	204.246	64			

Table above shows that F (1, 62) = 1.275; p = 0.263 > 0.05. This means that the result of test of significance is higher than the benchmark 0.05; consequently, the null hypothesis is accepted. This implies that there is no significant difference in the mean achievement score of male and female students taught biological concepts using concept-mapping pedagogical strategy.

DISCUSSION OF FINDINGS

The findings of the research indicated that students in the concept-mapping group achieved better than the jigsaw group because there was a significant difference in the achievement scores of the two groups. The significant difference observed in this finding implies that using concept-mapping strategy to teach students nervous coordination will make them achieve better than if jigsaw strategy is used. This further signifies that concept-mapping pedagogical strategy enhances students achievement in nervous system better than jigsaw .This is in alignment with Studies by

Adeniran et al. (2018) where it was found out that concept mapping pedagogical strategy improves students retention in Basic Science significantly, which is particularly useful for subjects such as biology. The strategy allows students to visualize relationships among key concepts, leading to better integration and recall of biological information. This finding is also consistent with the findings of Awodun (2017) who found out that student in concept mapping teaching strategy group performed significantly better than their counterparts of the conventional method. This finding disapproves with the findings of Dat (2016) who found out that students in the jigsaw group had greater long-term achievement than those in the conventional lecture method.

Findings also revealed that, there is no significant difference in the mean achievement scores of male and female students taught biological concepts using jigsaw and concept mapping pedagogies. This means that both male and female students will have the same level of achievement when taught nervous system using jigsaw and concept mapping pedagogies. This finding aligns with the study by Fassi and Istifanus (2022) who the finding on gender revealed that there is no statistical significant difference in the achievement scores of male and female students taught using jigsaw II learning strategy. This finding is also consistent with Danjuma et al, (2024) which revealed that there is no statistical significant difference in the performance and retention scores of male and female students taught Basic Science using ethno science enriched instruction strategy. This finding on gender disagrees with the findings with Adeniran et al. (2018) they opined that there is a significant difference in the retention scores of the female compared to the male students taught Basic Science using concept mapping pedagogy.

CONCLUSION

Based on the findings of this work, concept-mapping pedagogy enhances students' achievement in biology better than jigsaw pedagogy. Subsequently, teachers should prioritize using concept-mapping pedagogy in teaching Biology, especially nervous system. One benefit accompanying the use of this strategy is that it is not gender sensitive. Since students' achievement is not gender selective, the choice of gender-friendly strategies such as concept-mapping becomes imperative to the classroom teacher.

RECOMMENDATIONS

1. Biology teachers should use concept-mapping pedagogical strategy to teach nervous system whenever there is evidence of low achievement in the topic
2. Biology teachers could use jigsaw pedagogical strategy whenever female students achieve more than male students or whenever male students achieve more than female students.
3. Biology teachers could use concept-mapping pedagogical strategy whenever female students achieve more than male students or whenever male students achieve more than female students.

REFERENCES

Badri, M., Alnuaimi, A., Yang, G., Rashedi, A. A. (2020). Examining the relationship of factors influencing students' mathematics achievement. *International Journal of Innovation in Education,* 6(1), 12-32.

Famuwagun, S. T., & Ojobola, F. B. (2021). Comparative effectiveness of virtual laboratory instructional package in teaching chemistry in private and public secondary schools. *Journal of Chemistry Education Research and Practice,* 5(2), 131-137.

Joshi S. H., & Green, E. R. (2024, February 17). *Biology* https://www.britannica.com/science/biology

Ibrahim, I. K., Tukura, C. S., Adamu, Z. E., Ajiboye, M. B., Mohammed, A. N., Opalere, O. T. (2018). Role of concept mapping instructional strategy on achievement and retention of low-

achieving biology students in senior secondary schools in Minna Metropolis. *Journal of Science, Technology, Mathematics and Education*, 14(1), 168-178.

Ajayi, V. (2017). *Effect of hands-on activities on senior secondary chemistry students achievement and retention in stoichiometry in zone c of Benue State*. [Unpublished Master's Dissertation] Benue State University, Makurdi.

Daiko, C. T. (2023). *Comparative effects of jigsaw, think-pair-share, and coop-coop cooperative instructional strategies on achievement, retention and interest of students in carbohydrate.* [Unpublished PhD Thesis]. Taraba State University, Jalingo.

Mari, J. S., & Gumel, S. A. (2015). Effects of jigsaw model of cooperative learning on self-efficacy and achievement in chemistry among concrete and formal reasoners in colleges of education in Nigeria. *International journal of information and education technology*, 5(3), 196-197.

Daiko, C., Achor, E. E., & Jack, G. U. (2023). Jigsaw, think-pair-share and coop-coop cooperative instructional strategies and retention of students' knowledge in carbohydrate. *Journal of Research in Science and Mathematics Education (J-RSME),* 2(3), 117-135.

Ogonnaya, U. P., Okafor, G., Abonyi, S. O. & Ugama, J. O. (2016). Effects of Concept Mapping Instruction Approach on Students' Achievement in Basic Science. *Journal of Education and Practice*, 7(8), 79-84.

Tarim, S. L., Boy, Y., & Sanliturk, D. (2022). Effectiveness of the concept map in nursing education; developing a tool for student opinions. *Hospital Practices and Research*, 7(2), 69-76.

Danjuma, T. (2017). Comparing the objectives, themes, and subthemes integrated and basic science curriculum of junior secondary schools. *Journal of Science Teachers Association of Nigeria*, 45(1&2), 36-47.

Owoyemi, T. E., & Adesina, A. S. (2021). The role of gender on chemistry teachers' knowledge of green chemistry in Lagos State Nigeria. *Benin Journal of Educational Studies*, 27(1), 28-32.

Chukwuemeka, I. P. & Dorgu, T. E. (2019). Students' perceptions of the difficult topics in biology at senior school level in Delta State, Nigeria*. Journal of advances in education and philosophy, 3(2),* 62-66.

Dat, T .V (2016). The effects of jigsaw learning on students' knowledge retention in Vietnamese Higher Education. *International journal of Higher Education, 5(2), 236-253.*

Adeniran, S.A., Ochu, A.N.O., & Atoo, S.F. (2018). Effects of concept mapping on students' retention in Basic Science in Benue State Nigeria. *International journal of research & Reviews, 5(5), 193-200.*

Danjuma, G.S., Maikano, S., & Umoru, E. S. (2024). Towards scaling up students' performance and retention in Basic Science using Ethno science enriched instruction. *International journal of Research and Advancement in Education,* 10(2), 114-123.

Fasasi, K. M. & Istifanus, H. (2022). Effect of jigsaw II cooperative learning strategy on senior secondary school students' Academic Achievement in Algebra in Gombe State, Nigeria. *AJSTME,* 8(2), 169-175.

Awodun, A. (2017). Effect of concept mapping teaching strategy on students' academic performance and retention in senior secondary school in physics in Ekiti State Nigeria. *International journal for Research in Educational studies, 3(6), 10-18.*

Ukeh, B.O & Anih, A.A. (2023). Effect of jigsaw instructional strategy on senior secondary school students' Academic Acheievement in data processing in Baylsa State, Nigeria. *Journal of research in science and vocational Education,* 3(1), 65-74.