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EFFECT OF JIGSAW AND PEER-TUTORING INSTRUCTIONAL STRATEGIES ON SENIOR SECONDARY SCHOOL STUDENTS' ACADEMIC ACHIEVEMENT AND INTEREST IN PERIODIC TABLE OF ELEMENTS IN ANKPA LOCAL GOVERNMENT AREA OF KOGI STATE

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ABSTRACT
The study examined the effect of Jigsaw and Peer–tutoring instructional strategies on students' achievement and interest in periodic table of elements. The research design used for this study was quasi-experimental design of non-equivalent group involving pretest and posttest. The target population of the study was 2, 996 (1210 males and 1786 females) Senior Secondary Schools II chemistry students for 2021/2022 academic session in all 57 secondary schools in Ankpa LGA of Kogi State. A sample of 129 (59 males and 70 females) SS II students from two secondary schools purposively sampled in the study area. Four research questions and four hypotheses guided the study. Periodic Table of Elements Achievement Test (PTEAT) and Periodic Table of Elements Interest Scale (PTEIS) were instruments used for data collection. The instruments were validated by experts and pilot tested. A reliability coefficient of 0.92 was obtained for PTEAT using Kuder-Richardsons K-21 and 0.89 for PTEIS using Cronbach Alpha implying that the instruments were reliable for the study. Descriptive statistics of mean and standard deviation were used to answer the research questions while Analysis of Covariance (ANCOVA) was used to test the research hypotheses at 0.05 alpha level of significance. Findings of the study revealed that jigsaw and peer-tutoring instructional strategies have significant effect on students' academic achievement and interest in periodic Table of elements concept of chemistry. Also, gender and interest have no influence on the academic achievement of students exposed to Jigsaw and peer tutoring instructional strategies Based on the findings, it was recommended among others that chemistry teachers should be encouraged to adopt problem-based learning strategy in teaching chemistry concepts during their instructional practices. Based on the findings of this study, it was recommended that chemistry teachers should incorporate Jigsaw and peer- tutoring instructional strategies into the teaching of Chemistry to enhance students' achievement and interest in secondary schools in Kogi State, Nigeria.

Keywords: Achievement, Interest, Gender, Chemistry, Jigsaw and Peer-tutoring Instructional Strategies.

Introduction

It is widely and generally acknowledged that the gateway to the survival of a nation scientifically and technologically is scientific literacy which can only be achieved through science education (Bilesanmi-Awoderu & Oludipe, 2012). On this note, science education has been recognized as a vital tool for achieving sustainable development. Science education is regarded as a veritable test for economic and technological development in the areas of self-reliance and self-sufficiency because it is the platform and the process that leads to the production of citizens who are creative, critical, analytical and rational (Enuma & Onah, 2017). Science education is also the backbone of developing countries because sustainable development of economy and society is achievable if knowledge in science education is embraced (Enemuo, Anyaduba & Ezeaka, 2019). This is because science educations assist the learners in developing certain attitudes, knowledge and skills regarding the order in nature (Suleiman & Mathew, 2010). Therefore, there is need to produce scientifically and technologically literate citizens that can sustain the

natural environment and improve national development. In line with this, National Policy on Education (FRN, 2013) identified the goals of science education to include:

- Acquisition of knowledge, skills, inquiry and rational mind for conduct of good life.
- Produce scientist for national development.
- Service studies in technology and the cause of technological advancement.
- Understanding of the physical world, the forms and conduct of life and
- Provide knowledge and understanding of the complexity of the physical world, the forms and conduct of life.

Within the context of science education, Chemistry occupies a unique position in the scientific and technological advancement of any country in the world today (Ibrahim, Tairo, Aminu, Isah & Muhammad, 2017). Chemistry is a central science that forms the indispensable foundation of many disciplines such as biology, physics, medicine, plant sciences, nuclear chemistry, engineering, geology, cosmetics, and environmental science (Salman, Olawoye & Yahaya, 2011). The relevance of Chemistry in scientific and technological development of any nation has been widely reported (Agogo & Onda, 2014 and Ayodele, 2018). Chemistry is the catalyst of sustainable national growth and development. Emmanuel (2013) sees chemistry education as the vehicle through which chemical knowledge and skill reach the people who are in need of capacities and potentials for development. Chemistry is offered at the senior secondary classes in order to help student learn important aspects of scientific concepts that would enable them live effectively in their immediate environment (Jimson, 2018). It was as a result of the recognition given to chemistry in the development of the individual and the nation that it was made a core-subject among the natural sciences and other science related courses in Nigerian Education system such as medicine, biochemistry, pharmacy, pharmacognocy, agricultural science, laboratory technology, geology, toxicology etc (Bugaje, 2013). No student can study these disciplines without Chemistry.

Despite the importance of chemistry and its education value which is relevant to the need of individual learner, economics and technological breakthrough of a nation and the effort of researchers to improve on its teaching and learning, performance in chemistry at the secondary school remains low and unimpressive as disclosed by several researchers. For instance, according to Nwankwo and Okigbo (2021), the WAEC Chief Examiners' report revealed that the performance of candidates in Chemistry paper 2 as at 2018 with mean score of 29 and standard deviation of 13.78 was worse than candidates' performance in 2017 with mean score of 47 and standard deviation of 13.78. Similarly, it was further reported that the performance of candidates in Chemistry paper 3 as at 2018 with mean score of 24 and standard deviation of 9.95 was worse than candidates' performance in 2017 with mean scores of 26 and standard deviation of 8. These result analyses denote a decrease in the performance of students in Chemistry for those years. These analyses agreed with the researches of Uchegbu, Anozieh, Mbadiugha, Ibe and Njoku (2015) and Muhammad (2014) that students' performance in chemistry in the Secondary School Certificates Examination (both WAEC and NECO) reveal that only a very negligible number of students perform well in the examinations.

Many reasons have been attributed for the observed poor performance and lack of interest in Chemistry by students. One of the reasons according to Agogo and Onda, (2014) is that, Chemistry is deemed abstract and difficult by students. This was also reported by Uchegbu, Oguoma, Elenwoke and Ogbuagu (2016) who discovered that Chemistry students perceived some Chemistry topics like gas laws, mass volume relationship, hydrocarbons, and alkanols difficult to learn. They further reported that students perceived Chemistry syllabus to be too wide, too abstract and involving too many calculations. In a related research, Uzezi, Ezekiel and Auwal (2017) reported that, students perceived chemistry concepts like symbols, formulae and equations, acids, bases and salts, organic chemistry, structure and energy level of atom, quantitative analysis, chemical equation, non metals and their compounds, thermo chemistry, metals and their compounds, applied

chemistry, nuclear chemistry and astronomical chemistry as difficult. Kabutu, Oloyede and Bandele (2015) attested that poor instructional strategies employed in the teaching of sciences especially chemistry by teachers contributes to students under achievement. Hejiamaizu, Ukor and Neji (2018) equally noted poor teaching strategies which the teachers utilize in teaching chemistry concepts as contributory to these problems among other reasons. Nja, Cornelius-Ukpebi, Edoho and Neji (2020) on their part noted consistent poor performance of secondary school students in Chemistry and attributed the cause to defective teaching strategy.

For effective instruction, a chemistry teacher must be able to use several science teaching strategies and to implement them where they are applicable and most effective (Omwirhiren & Ibrahim, 2016). Udu (2018), the selection of an appropriate instructional delivery approach portrays good teaching technique and facilitates successful learning. For this reason, the chemistry teachers should de-emphasize the use of teacher-centered and traditional "chalk talk" approaches of teaching. They should rather embrace more innovative, student-centered and activity-based approaches of teaching, which have been reported to be more effective in realizing the objectives of chemistry education (Neboh, 2012). These imply that the use of strategies in which the learner plays the most active part and interact with each other to construct their own knowledge is advocated. There is need for a shift from teacher-centered methods of teaching to student centered method. To realize this, jigsaw and peer-tutoring instructional strategies become necessity in this study.

Peer-tutoring is described by Okoye (2016) as an instructional strategy in which students in their groups, under the guidance of a teacher, work together through a given instructional assignment with brilliant student as a peer tutor, providing assistance and instruction to others. On their part, Okechukwu, Uyin and Nonye (2019) held that peer-tutoring is an instructional strategy whereby students are taught by their peers who had been trained or given orientation by their class teacher. The class teacher acts as an advocate, collaborator, facilitator and mentor. He organises, monitors and supervises peer-tutoring sessions and so helps to manage the problems associated with timing, meeting place, punishments and other technicalities. Key attributes of peer tutoring are (a) frequent verbal interaction and feedback, (b) positive reinforcement, (c) teacher or facilitator monitoring, (d) structured higher level thinking activities, and (e) supportive learning environment (Worley & Naresh, 2014). This strategy links high achieving students with low achieving students or those with comparable achievement for structured reading and mathematics study session (Rohrbeek, 2013). Several benefits have been documented across the literature for both tutors and tutees during peer tutoring experiences. The social implications of peer tutoring are also valuable, as it fosters student inclusion (Malone, Fodor & Hollingshead, 2019) and improves the class climate (Jean-Francois, 2017). Both tutors and tutees benefit from this methodology. Tutees benefit from receiving direct instruction from a peer. As students share a similar discourse, tutees usually feel more comfortable, ask more questions, and better understand the content (Ayvazo & Aljadeff-Abergel, 2019).Tutors benefit as they reinforce their knowledge by answering the tutees' questions. These interactions between tutors and tutees promote active learning and foster student inclusion, as all students participate in the process (Fung, Tan & Chen, 2018).

Similarly, jigsaw activity is a teaching practice in which learners are responsible for learning the material and teaching it to other learners. Jigsaw strategy encourages student participation in a classroom where learners have a critical role for success and this success depends on active cooperation and participation. Using Jigsaw strategy increases the variety of learning experiences, and teaches learners course content and cooperative social skills (Perkins & Tagle, 2011). Jigsaw strategy has been designed to promote cooperation by making individuals dependent on each other. In this strategy, each student is responsible for learning a part of a broad topic and teaching it to other learners. That is, each learner is dependent on other group members to learn the main topic (Buhr, Heflin, White, & Pinheiro, 2014). According to Turacoglu, Alpat and Elleg (2013), the Jigsaw classroom teaching and learning is of four basic steps. A jigsaw class is divided into several small

groups called 'home groups' usually made of 3-7 members each, and assigned with subtopics of the same theme or topic. After preparation of the subtopic, the class then re-groups into new groups (expert groups), with a member from each of the former (home) groups with corresponding subtopics forming part of the new group to interact and become 'experts' in the respective subtopics. Each member will then go back to his 'home group' to interact, with the experts in each subtopic taking turns to teach his home group the subtopic in which he is an 'expert'. This is followed by a class assessment. The Jigsaw strategy has been found to improve students' achievement (Timayi, Bolaji & Kajuru, 2015), enhance social learning as well as increase capacity for self-actualisation by students (Sahin, 2016).

The vision and practice of jigsaw and peer instruction instructional strategies relate to the social positive interdependence theory. Positive interdependence (cooperation) results in promotive interaction as individuals encourage and facilitate each other's efforts to achieve. Positive interdependence exists when individuals' goal achievements are positively correlated; individuals perceive that they reach their goals if and only if the others in the group also reach their goals (Laal, 2013). To Johnson, Johnson and Smith (2013), Jigsaw and Peer Tutoring strategies draw strength from positive interdependence in the social systems (classroom). This is because positive interdependence depends on interactions between individuals which in turn determine outcomes. In Jigsaw and Peer tutoring strategies, the learners invest positive emotion in each other, and are open to being influenced by each other. Positive interdependence exists when collaborators engage in promotive interactions which manifest in helping, sharing, encouraging one another (Emmanuel & John, 2020). The implication is that where there is conscious promotion of positive interdependence in a social system there is vision of strict interdependence among the members such that members act in realisation that individuals' goal achievements are positively correlated; individuals perceive that they reach their goals if and only if the others in the group also reach their goals. This applies to both jigsaw and peer-tutoring strategies. The success (achievement) of each group member is assured if and only if the success of every other member is assured through mutual cooperation of learners. When well organised, each member of the group help, provide for, encourage, cooperate with, share with, listen to, accommodate and appreciate other members of the group interdependently (Emmanuel & John, 2020).

It has been shown by Okoli (2012), that students' achievement in science subjects is gender dependent. Gender, as a concept, has captured the interest of educators in Nigeria, especially now that gender equity is being emphasized in many quotas (Filgona & Sababa, 2017). According to Ezechi and Adukwu (2018), gender inequalities have always existed and can be viewed from different perspectives, which includes subjects allocated to a particular gender as being more relevant to the dispositions and academic performances of students. Adedamola (2015) contend that gender had no significant influence on students' achievement in science. While on the contrary, Azibaolanari, John and Mumuni (2016) reported a significant difference in achievement between male and female students in science. In a related study, Wonu & Anackwe (2014) found out no significant difference in the mathematic achievement of male and female students. Interest is another variable that could always be a factor in the issue of students' academic achievement. Nwafor and Oka (2018) opined that when students are allowed to pursue their own interests, they participate more, stay involved for longer periods, and exhibit creative practices in doing science at the same time. When student's interest increases, understanding becomes enhanced and retention ability increased (Gilakjani, 2012). If a student shows a higher interest in a subject, this will help him to put in more time, effort and energy in learning which will in turn lead to higher or better achievement (Godpower-Echie & Ihenko, 2017). The interest in the field of study in students is one of the criteria for satisfaction and academic achievement that affects many of their affairs (Qarehaghaji & Mirahadi, 2014). Ukoh (2010) revealed that there is a significant relationship between students' interest and students' performance. Ukoh therefore, recommended that there is need for teachers to make their lessons

captivating to the students by relating science to the environment of the learners and using the appropriate teaching strategy to arouse and maintain students' interest in the subject. Conscious efforts therefore need to be made to prepare these students with a view to capturing their interest and enhancing their achievement in sciences (Olatoye, 2017). However, instructional strategies like jigsaw and peer-tutoring may remedy differences in male and female students' interest, academic achievement in chemistry.

Statement of the Problem

The need to use activity-oriented and learner-centered strategies of teaching is emphasized in the Nigerian National Policy on Educations (FME, 2013), which states that educational activities shall be centered on the learner for maximum self development and fulfilment and the education system shall be structured to develop the practice of self learning. Unfortunately, for many years, classroom practices have been mainly dominated by teacher-centered approaches, which greatly enhanced passive learning. The problem in many secondary schools in Ankpa local government education zone is that some science teachers continue to teach with conventional methods of instruction such as lecture and note taking, instead of using methods in which active learning place. The use of inappropriate method in teaching chemistry renders adequate facilities unproductive and promotes concept difficult, misconceptions and leads to rote memorization of facts and ideas about the concept, which constitutes a problem.

On this note, there is need to explore student-centred, activity-oriented focused teaching strategies with radical applications to enhance the teaching of concepts of chemistry. The purpose of this study is to examine effect of jigsaw and peer-tutoring instructional strategies on students' academic achievement and interest in periodic table of elements concept of chemistry.

Research Questions

The following research questions were posed to guide the study:

(i) What are the effects of jigsaw and peer-tutoring instructional strategies on students' academic achievement and interest in periodic table of elements concept of chemistry?

(ii) What are the effects of jigsaw and peer-tutoring instructional strategies on students' interest in periodic table of elements concept of chemistry?

(iii) What are the effects of jigsaw and peer-tutoring instructional strategies on male and female students' academic achievement mean scores in periodic table of elements concept of chemistry?

(iv) What are the effects of jigsaw and peer-tutoring instructional strategies on male and female students' interest mean scores in periodic table of elements concept of chemistry?

Research Hypotheses

The following null hypotheses (HO) were formulated and tested at 0.05 level of significance.

HO_1: There is no statistical significant difference in the mean achievement scores of students taught periodic table of elements using jigsaw instructional strategy and those taught with peer-tutoring instructional strategy.

HO_2: There is no statistical significant difference in the mean interest scores of students taught periodic table of elements using jigsaw instructional strategy and those taught with peer-tutoring instructional strategy.

HO_3: There is no statistical significant difference in the mean achievement scores of male and female students taught periodic table of elements using jigsaw instructional strategy and those taught with peer-tutoring instructional strategy.

HO_4: There is no statistical significant difference of interest mean scores of male ad female students taught periodic table of elements using jigsaw instructional strategy and those taught with peer- tutoring instructional strategy.

Research Method

The research design adopted quasi-experimental design based on pre-test, post-test non-equivalent control group. This design was considered appropriate for this study because the subjects were made up of two experimental groups where each group was made up of intact class. For this purpose, first experimental group formed Jigsaw instructional strategy group while second

experimental group formed Peer- tutoring group. The study was conducted in Ankpa local government area of Kogi state. The target population of the study was made up of 2, 996 (i.e. 1210 males and 1786 females) Senior Secondary Schools II chemistry students in all 57 approved secondary schools in Ankpa Local Government Area of Kogi state.

In addition, the choice of SS II students was because the topic used is contained in SS II chemistry syllabus. Purposive sampling technique was used to select two equivalent co-educational secondary schools that are distantly located from one another within Ankpa LGA which are considered intact class setting. The criteria for their selection includes: The schools were government approved schools; the schools were co-educational; the schools have a reasonable number of SS chemistry students; the schools have WAEC and NECO centres for not less than ten years; the schools have conducive classroom environment; the schools have at least a chemistry teacher with first degree with at least 5 years of teaching experience and the schools have functional laboratory. The sample of the study comprised of 129 SSS II students consisting 70 females and 59 males.

Two instruments were developed by the researchers and used for data collection. The instruments were Periodic Table of Elements Achievement Test (PTEAT) and Periodic Table of Elements Interest Scale (PTEIS). PTEIS was a 25 items designed to determine students' interest in periodic table of elements. PTEIS was rated on using a four-point Likert-type scale. Also, The PTEAT was a 50-itemed multiple choice achievement tests with option A-D drawn from previous standardized examination questions of West African Examination Council and Unified Tertiary Matriculation Examination on periodic table of elements. The PTEAT and PTEIS were administered twice, before (pre) and after (post) the experiment. The PTEAT and PTEIS were subjected to face and content validation to the experts drawn from department of curriculum studies, department of chemistry and measurement and evaluation, Kogi State College of Education Ankpa. Based on the comments and suggestions from the experts, corrections and modifications were made on the instruments. For reliability, The PTEAT and PTEIS were pilot tested using an intact SS II class of 30 students of senior secondary school in Okpo (Olamaboro LGA of Kogi state). The school has similar characteristics to sample schools. The reliability of PTEIS was determined using Crombach alpha formula which gave the coefficient of 0.92 while reliability of PTEAT was determined using Kuder Richardson 21 (K-R_{21}) formula and coefficient was found to be 0.89 implying that the instruments were reliable for the study.

Experimental Procedures

The researchers used the permanent chemistry teachers in the sampled secondary schools as research assistants, to teach periodic table of elements in their respective intact classes. The use of permanent teachers was to make the experimental process conform to normal chemistry lessons of the class thereby eliminating suspicious by the students which might have affected the reasons of the subjects to the treatments. One-week training programme was organized for the permanent chemistry teachers on how to implement respective researchers-made instructional procedures and lesson plans for jigsaw and peer tutoring instructional strategies. Afterwards, the PTEAT and PTEIS were administered to the students as a pre-test in the first week of the research before the commencement of the treatment. This will help to establish the entry behaviour of the students before the actual treatment. After six weeks of the treatment, the PTEAT and PTEIS which earlier served as pre-tests were reshuffled and administered as post-test to the students to determine the effect of the treatment. The treatment was completed within a period of eight weeks. For data analysis, the research questions were answered using descriptive statistics such as mean and standard deviations while all the hypotheses were tested at 0.05 level of significance using Analysis of Co-variance (ANCOVA) with the pre-test scores as a covariate.

Results and Discussion

Research Question One: What are the effects of jigsaw and peer-tutoring instructional strategies on students' academic achievement and interest in periodic table of elements concept of chemistry?

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Table 1: Mean and Standard Deviation Scores of Students' Achievement Scores in Periodic Table of Elements Based on Instructional Strategies

Treatment Groups		**Pre-test**		**Post-test**		**Mean Score Gain**
	N	**Mean**	**SD**	**Mean**	**SD**	
Jigsaw	66	14.16	3.968	63.98	9.612	49.82
Peer-tutoring	63	14.26	3.434	62.98	10.477	48.72

Source: Field Study
Key: N= Number of student and SD= Standard Deviation

Data in Table 1 shows that both jigsaw and peer-tutoring instructional strategies had higher post-test mean achievement scores than the pretest mean achievement scores. In addition, the mean gain of the achievement scores of students taught periodic table of elements using jigsaw instructional strategy is 49.82 while those taught with peer- tutoring instructional strategy is 48.72. This indicates that, students taught using Jigsaw instructional strategy performed slightly better than those taught with peer tutoring instructional strategy. The difference in the mean achievement scores of the treatment groups is examined by testing hypothesis one.

Hypothesis One: There is no statistical significant difference in the mean achievement scores of students taught periodic table of elements using jigsaw instructional strategy and those taught with peer-tutoring instructional strategy.

Table 2: Result of ANCOVA on Achievement Mean Scores of Students taught Periodic Table of Elements Based on Instructional Strategies for Testing Hypothesis One.

Source	**Type III Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig.**	**Partial Eta Squared**
Corrected Model	731.670[a]	2	365.835	3.796	.025	.057
Intercept	24016.643	1	24016.643	2.492E2	.000	.664
Pre-test	678.268	1	678.268	7.037	.009	.053
Group	58.630	1	58.630	.608	.437	.005
Error	12144.656	126	96.386			
Total	530183.000	129				
Corrected Total	12876.326	128				

a. R Squared = .057 (Adjusted R Squared = .042) p=0.437>0.05

Table 2 reveals that the ANCOVA test F= 0.608, p>0.05. This implies that, there is no statistical significant difference in the mean achievement scores of students taught periodic table of elements using jigsaw instructional strategy and those taught with peer tutoring instructional strategy. The null hypothesis 1 is retained which means that there is no statistical significant difference in the mean achievement scores of students taught periodic table of elements using jigsaw instructional strategy and those taught with peer-tutoring instructional strategy.

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Research Question Two: (ii) What are the effects of jigsaw and peer-tutoring instructional strategies on students' interest in periodic table of elements concept of chemistry?

Table 3: Mean and Standard Deviation of Chemistry Students' Interest Scores Taught Periodic Table of Elements Based on Instructional Strategies

Treatment Groups	**Pre-Interest**		**Post-Interest**		**Mean Score Gain**
	N	**Mean**	**SD**	**Mean**	**SD**
Jigsaw	66	23.46	0.763146	76.51	0.7544	53.05
Peer-tutoring	63	25.07	.3270	74.93	6.3270	49.86

Source: Field Study

Table 3 reveals that both jigsaw and peer-tutoring instructional strategies had higher post-interest mean scores than the pre-interest mean scores. In addition, the mean gain of the interest scores of students taught periodic table of elements using jigsaw instructional strategy is 53.05 while those taught periodic table of elements with peer- tutoring instructional strategy is 49.86. This shows that, those taught using jigsaw instructional strategy developed more interest in learning than those who were taught using peer-tutoring instructional strategy. The difference in the mean interest scores of the treatment groups is examined by testing hypothesis two.

Hypothesis Two: There is no statistical significant difference in the mean interest scores of students taught periodic table of elements using jigsaw instructional strategy and those taught with peer-tutoring instructional str

Table 4: Result of ANCOVA on Interest Mean Scores of Students taught Periodic Table of Elements Based on Instructional Strategies for testing hypothesis two

Source	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**.Sig.**	**Partial . Eta Squared**
Corrected Model	2595.029[a]	2	1297.514	41239.258	.000	.998
Intercept	41382.437	1	41382.437	1315269.454	.000	1.000
Pre-interest	2514.973	1	2514.973	79934.079	.000	.998
Group	.032	1	.032	1.002	.319	.008
Error	3.964	126	.031			
Total	742513.660	129				
Corrected Total	2598.993	128				

a. R Squared = .998 (Adjusted R Squared = .998) P= 0.319> 0.0

Data in Table 4 shows that the ANCOVA test F= 1.002, p=0.319 >0.05. This implies that there is no significant difference in the mean interest scores of students taught periodic table of elements using jigsaw instructional strategy and those taught with peer tutoring instructional strategy. The null hypothesis 2 is retained which means that students taught periodic table of elements using

jigsaw instructional strategy and those taught with peer-tutoring instructional strategy developed interest equally.

Research Question Three: What are the effects of jigsaw and peer-tutoring instructional strategies on male and female students' academic achievement mean scores in periodic table of elements concept of chemistry?

Table 5: Mean and Standard Deviation of Genders' Achievement Scores Exposed to Periodic Table of Elements Based on Instructional Strategies

Treatment Groups			Pre-test		Post-test		Mean Score Gain
	N	Gender	Mean	SD	Mean	SD	
Jigsaw	30	Male	14.59	3.6107	64.10	10.6078	49.51
	36	Female	13.79	4.2696	63.88	10.5220	50.09
Peer-tutoring	29	Male	14.53	3.2455	63.20	9.0417	48.67
	34	Female	14.03	3.6134	62.28	10.1885	48.25

Results in Table 5 reveal that both male and female students taught periodic table of elements using jigsaw and peer-tutoring instructional strategies had higher post-test mean achievement scores than the pre-test mean achievement scores. Also, the mean gain of the achievement scores of male students is 49.51 and female students is 50.09 exposed to jigsaw instructional strategy while the mean gain of the achievement scores of male students is 48.67 and female students is 48.25 exposed to peer-tutoring instructional strategy. This shows that, the male and female students in jigsaw group had equal mean achievement scores while male and female students in peer-tutoring group performed equally. The difference in the mean achievement scores of male and female students exposed to treatment groups is examined by testing hypothesis three.

Hypothesis Three: There is no statistical significant difference in the mean achievement scores of male and female students taught periodic table of elements using jigsaw instructional strategy and those taught with peer-tutoring instructional strategy.

Table 6: Result of ANCOVA on Achievement Mean Scores of Male and Female Students taught Per Based on Instructional Strategies for Testing Hypothesis Three

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	738.864[a]	4	184.716	1.887	.117	.057
Intercept	23758.631	1	23758.631	242.75	.000	.662
Pre-test	670.780	1	670.780	6.853	.010	.052
Group	54.931	1	54.931	.561	.455	.005
Gender	.891	1	.891	.009	.924	.000
Group * Gender	6.187	1	6.187	.063	.802	.001
Error	12137.461	124	97.883			
Total	530183.000	129				
Corrected Total	12876.326	128				

a. R Squared = .057 (Adjusted R Squared = .027), P= 0.802> 0.05

Data in Table 6 shows that the ANCOVA test F= 0.063, p>0.05. This implies that there is no statistical significant difference between the mean achievement of male and female students exposed to jigsaw and peer -tutoring instructional strategies. The null hypothesis 3 is retained which implies that male and female students taught periodic table of elements using jigsaw instructional strategy and those taught with peer-tutoring instructional strategy achieved equally.

Research Question Four: What are the effects of jigsaw and peer-tutoring instructional strategies on male and female students' interest mean scores in periodic table of elements concept of chemistry?

Table 7: Means and Standard Deviation of Interest Mean Scores of Male and Female Students taught Periodic Table of Elements Based on Instructional Strategies

Treatment Groups			Pre-interest		Post-interest		Mean Score Gain
	N	Gender	Mean	SD	Mean	SD	
Jigsaw	30	Male	23.45	0.76282	76.55	0.7628	53.10
	36	Female	23.47	0.7741	76.45	0.7559	52.98
Peer-tutoring	29	Male	24.66	6.3333	75.09	6.3589	50.43
	34	Female	25.21	6.3920	74.79	6.3920	49.58

Source: Field Study

Results in Table 7 reveal that both male and female students taught periodic table of elements using jigsaw and peer-tutoring instructional strategies had higher post-interest mean scores than the pre-interest mean scores. Also, the mean gain of the interest scores of male students is 53.10 and female students is 52.98 exposed to jigsaw instructional strategy while the mean gain of the interest scores of male students is 50.43 and female students is 49.58 exposed to peer- tutoring instructional strategy. This shows that, the mean interest scores of male and female students in jigsaw and peer-tutoring groups are equal. The difference in the mean interest scores of male and female students exposed to treatment groups is examined by testing hypothesis four.

Hypothesis Four: There is no statistical significant difference of interest mean scores of male ad female students taught periodic table of elements using jigsaw instructional strategy and those taught with peer-tutoring instructional strategy.

Table 8: Result of ANCOVA on Interest Mean Scores of Male and Female Students taught Periodic Table of Elements Based Instructional Strategies

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	2595.090[a]	4	648.772	2.061E4	.000	.998
Intercept	41372.066	1	41372.066	1.314E6	.000	1.000
Pre-interest	2513.466	1	2513.466	7.985E4	.000	.998
Group	.026	1	.026	.828	.364	.007
Gender	.030	1	.030	.959	.329	.008

Group * Gender	.030	1	.030	.940	.334	.008
Error	3.903	124	.031			
Total	742513.660	129				
Corrected Total	2598.993	128				

a. R Squared = .998 (Adjusted R Squared = .998) P=0.940 > 0.05

Data in Table 8 reveals that the ANCOVA test F= 0.940, p>0.05. This implies that there is no statistical significant difference between the mean interest scores of male and female students taught periodic table of elements using jigsaw instructional strategy and those taught with peer tutoring instructional strategy. The null hypothesis 4 is retained which implies that male and female students exposed to jigsaw and peer-tutoring instructional strategies developed more interest in learning equally.

Discussion of Results

This study examined effect of jigsaw and peer-tutoring instructional strategies on students' academic achievement and interest in periodic table of elements concept of chemistry in selected secondary schools in Ankpa local government area of Kogi State. The findings of the study showed that students who were exposed jigsaw instructional strategy performed slightly better than those exposed to peer-tutoring instructional strategy. The difference was not statistically significant. Thus confirmed that jigsaw and peer-tutoring instructional strategies are learner-centred and capable of making remarkable impact on instructional practices. The higher achievement recorded by both strategies may be due to the active interaction and active participation of all students in the treatment process. This result agrees with the finding of Chukwu and Arakoyu (2019); Sudrajat, Iasha and Femayati (2019); Odo and Nwachuckwu (2020) and Fakiye. (2021) who in their various studies reported that students taught using jigsaw and peer-tutoring strategies achieved better academically in sciences.

Also, it was discovered that students who were exposed to jigsaw instructional strategy developed interest slightly than students taught using peer tutoring instructional strategy. Although, the difference was not statistically significant. This result indicates that both jigsaw and peer-tutoring instructional strategy are more effective in enhancing students' interest in chemistry. This finding is consistent with the findings of Samuel and Sambo (2019) and Ojekwu (2020) who found that jigsaw and peer-tutoring have greater ability to increase the interest of students in sciences.

More so, it was discovered that both jigsaw and peer-tutoring instructional strategies are non-gender discriminatory instructional strategies. This indicates that gender is not a determinant of students' academic achievement. This finding agrees with findings of Etiubon and Ugwu (2018); Nwogo and Anugwo (2020) and Ojekwu (2020) that when both male and female students are given equal opportunities and allowed to be actively involved and fully participate in the learning process, they performed equally. Finally, it was equally noted that there is no statistically significant difference in the interest gain of male and female students exposed to jigsaw and peer-tutoring instructional strategies. This finding is in consonant with findings of Ojekwu (2020) and Areelu and Ladele (2018) who reported that gender does affect students' interest in learning chemistry concepts.

Conclusion

Based on findings of this study, it can be concluded that both jigsaw and peer-tutoring instructional strategies are more efficient in facilitating students' academic achievement and interest in chemistry concepts. The study however found no statistically significant difference between academic achievement and interest of male and female students exposed to jigsaw and peer-tutoring instructional strategies. This is indication that both jigsaw and peer-tutoring instructional strategies enhance students' academic achievement and interest in periodic table of elements irrespective of gender.

Recommendations

Based on the findings of this study, the following recommendations were made:

i. The use of jigsaw and peer-instructional strategies seem to be appropriate in improving the academic achievement and interest of students in senior secondary schools. It should therefore, be incorporated into the main stream of pedagogy in the teaching of Chemistry and other science subject at senior secondary schools in Ankpa Educational Zone, Kogi State to enhance students' active participation, achievement and interest on career paths.

ii. In the view of the fact that jigsaw and peer-tutoring instructional strategies improves students' academic achievement and interest, it is recommended that the curriculum planners should revisit the science curriculum in order to incorporate these strategies in the teaching and learning of chemistry concepts.

iii. Professional bodies like Science Teachers Association of Nigeria (STAN) along with other educational stakeholders through the ministry of education should organize and sponsor science teachers to participate in regular workshops to train them on the use of innovative instructional strategies like jigsaw and peer tutoring.

iv. Teacher education programmes in Nigerian tertiary institutions should be improved upon to prepare teachers on the use of innovative teaching strategies such as jigsaw and peer-tutoring which will promote effective teaching and learning of science.

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