

# Effects of Two Peer Instructional Strategies on Secondary School Students' Achievement in Science

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**Abstract** This research titled Effects of two peer instructional strategies on secondary school students' achievement in science was aimed at determining the relative effects of the Jigsaw and Peer Tutoring instructional strategies on secondary school students' achievement in science. Three research questions and three null hypotheses at 0.05 level of significance guided the study. Quasi-experimental design was adopted. The population of the study comprised all SS 2 science students in Abakaliki Education Zone of Ebonyi State Nigeria. The sample for the study was 202 science student. A 30-item instrument, Science Achievement Test was used for data collection. The instrument was face validated and the reliability coefficient tests gave 0.83 and 0.95 using Product Moment Correlation and KR-20 respectively. Permanent teachers of the sample classes taught chemical equilibrium and administered the pretest and posttest. Mean and standard deviation were used to answer the research questions. ANCOVA was used to test HO1 while t-test was used to test HO2 and HO3. The findings include that secondary school students taught science using Jigsaw instructional strategy had higher achievement mean score than students taught using the Peer Tutoring strategy, male students in the jigsaw group achieved higher than male students in peer tutoring group, female students taught science using the Jigsaw IV instructional strategy had significantly higher achievement mean score than female students taught using the Peer Tutoring instructional strategy and there was significant difference between the mean achievement scores of students taught science using Jigsaw instructional strategy and those taught using Peer Tutoring. The findings implied that jigsaw instructional strategy yields greater achievement. It was recommended among others that science teachers should make use of the Jigsaw instructional strategy to enhance students' achievement in science.

**Keywords:** science, Peer instruction, jigsaw strategy, peer tutoring, achievement

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## 1. Introduction

In the recent times, the world has been influenced by the culture of globalization such that there are overt efforts by many countries to redefine national educational goals and priorities in order to compete effectively in the emerging global village. The emerging direction in education has favoured the development of science and science education. Science is the use of evidence to construct testable explanation and prediction of natural phenomena, as well as the knowledge generated through this process [1]. According to UNESCO in [2] science is interconnected series of concepts and conceptual scheme that have developed as a result of experimentation and observation. In addition to these product views, science is also a process. [3: 31] stated that "science is a two-way activity that involves product (the knowledge and other outcomes of science) and process (the skills and scientific procedures of investigation)". From the views of [4]

science is the pursuit of and application of knowledge and understanding of the natural and social world following a systematic methodology based on evidence. Science is therefore, product, process and application, while the purpose of scientific activities has both natural forms and social dimensions. The products of science derive from evidence from experimentation and observations. Science is therefore, the systematic pursuit of knowledge of products, processes and application of natural world through experimentation and observation. Science is interdisciplinary, and in the course of time, has been differentiated into some bodies of knowledge, including biology, chemistry, physics, geology, botany and astronomy.

The relevance of science to the development of a nation has received attention in literature. For instance, Olurundare in [5:68] stated that the "development of any nation is usually measured by the degree and extent of socio-cultural, socio-economic and political improvements that are brought to bear through the enterprise of science and technology". Similarly, science has been identified to be instrumental to shaping and improving the destiny of

humanity [6]. The baseline purpose of science is the development of knowledge, skills and attitudes which fuse to facilitate social functions through technology to engender self-actualisation and national development.

Government of Nigeria has demonstrated various visionary interests indicative of her realisation of the inevitable roles of science in attainment of national goals. Consequently, the Federal Government, through policies, particularly National Policy on Education and National Policy on Science and Technology, has expressed national confidence on the efficacy of science to propel national development. The government has in evidence, defined roles and expectations for science in the national scheme. [7] noted that Nigerian government shall popularize the study of the sciences and the production of adequate number of scientists to inspire and support national development. Similarly, FRN cited in [8] stated that part of the objectives of the Nigeria National Policy on Science and Technology Education is to inculcate science and technology in the thinking and working processes of the society in order to create a science and technology culture. Government has also demonstrated her will to promote science in policies such as:

- Introduction of a quota system of 60:40 in favour of scientific disciplines in university admission.
- Creation of National Science and Technology Agency.
- Creation of Ministry of Science and Technology
- Establishment of Council for Science and Technology
- Establishment of universities of science and technology
- Launching of a National Science and Technology Policy.

The enormous commitments to the development of science underscore the fact that science is a social, economic and cultural factor of development. Like other socio-cultural factors, the society transmits science across generations and space through education. The instrument of education for the transmission or propagation of science knowledge, skill and attitude as well as presentation and utilization of the products of science is science education. [9] defined science education as that discipline which deals with sharing of science content and process with individuals who are not considered traditionally to be members of the scientific community.

Science education is an interdisciplinary field which incorporates education in the component fields of science, which includes biology education, chemistry education, physics education, mathematics education and basic science education. Science education aims at achieving the same aims of education through the study of science (Holbrook in [10]). The thrust of science education is to transform the learner into self-reliant person and active participant in socio-economic activities and effective contributor to nation building. Science education therefore equips and disposes the learner towards building himself for the overall social purpose.

Science education inculcates the knowledge (contents), skills (process skills) and positive attitude (scientific attitude) in the learner. Various science education curricula in Nigeria have been modelled and revised at various times with the background intention of

strengthening and redirecting purpose, contents and processes in line with emerging national needs and global trends. For instance the current secondary school science curricula was designed with the aim of aligning the curricula to the Education For All (EFA), the Millennium Development Goals (MDGs) and the National Economic Empowerment and development Strategies (NEEDS) [11].

Despite the composite nature of science education, there exists organic unity in practice. Basic commonalities are observable especially in pedagogy. What is most common is unified approach in terms of method of delivery of the skills and attitudes, and science practices. Science education embodies all education processes aimed at providing unlimited opportunities for learners to understand and utilize necessary knowledge, skills and attitudes required to operate effectively in a scientific and technological society [12]. The major concern of science education is enhancing the understanding of the physical world with a view to obtaining knowledge, attitude and skill to improve the individual and the society.

Despite the ambitious goals of science education at secondary school level in Nigeria as expressed in policy documents, output has not matched purpose in terms of achievement, self-reliance, self-employment and employability, social views and patriotic disposition of science graduates. There are so many science graduates who still roam the streets in search of job [13]. In terms of science achievement, [14] stated that there is persistent poor achievement of senior secondary school science students in public examinations.

One can easily point at hunger, poverty, ignorance, scarcity of portable water, prevalence of avoidable and preventable diseases, reduced life expectancy and poor maternal and child health as indications of failure of science education in Nigeria. Similarly, science has not addressed the challenges of lack of access to sanitation, HIV/AIDS scourge, loss of biodiversity, overpopulation, deforestation, desertification and decline in vital life support ecosystems which [15] noted, are tasks before science in Africa. Observations show that science classes at the senior secondary school level are scanty, relative to non-science classes. This, no doubt, transmits literally to low enrolment in sciences and science related courses at the tertiary level of education.

Low level of both application of science and students' achievements in science can be attributed to many factors, among which is poor or inappropriate instructional strategy/method of teaching and learning science. This is a fact as studies [16,17,18], [14] show that academic achievement in science depends on methods of teaching and learning. The implication is that poor achievement in the sciences can be traced to poor teaching methods.

Scientists and science educators have matched concerns with research efforts to find solutions to the challenges posed by students' poor achievement in science in particular, and the low level impact of science on the society especially in developing nations like Nigeria. Research focus towards determining how best to teach and learn science to achieve its set goals have been appreciable in the recent time. This is to ensure a successful sciencing (science education which results to attainment of the set goals). Successful sciencing can best be achieved when science is learnt using active learning

strategies [19]. Active learning strategies are activity oriented, involving hands-on interactive engagement of learners in the teaching and learning process. Teaching and learning thus make impact that can subsist in the daily life of the learner if the activities are learner-centred and teaching and learning are practical, activity-centred and experiential [20].

As noted by [21], the commonly used learner-centred, active learning strategies in science teaching include inquiry-approach, laboratory approaches, discovery methods, co-operative learning strategies and peer instructional strategies. This work is concerned with peer instructional strategies.

Peer instructional strategies are those strategies in which the teacher sets the environment for learning while the learners play the teacher-role to a small group of learners at short or long time duration. This can be made possible if the teacher relinquishes a great part of his role and authority to the learners and assumes more responsibility as a facilitator of learning. [22] defined peer instruction as a method where students are able to acquire knowledge through observation, study, teaching of other students, or through their own experiences. The most popular peer instructional strategies include reciprocal questioning, game-based learning, jigsaw instructional strategies, the pause procedure and the peer tutoring strategies. [22]

“Jigsaw is a strategy that involves students working in groups to become experts on specific topics” [23:3]. There are currently six types of jigsaw strategies available for use in the classroom, namely Jigsaw, Jigsaw II, Jigsaw III, Jigsaw IV, Reverse Jigsaw and Subject Jigsaw [24,25,26]. According to [27] 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 strategies have been found to improve students’ achievement [25,28], enhance social learning as well as increase capacity for self-actualisation by students [26], [25].

Peer tutoring instructional strategy is a peer instructional strategy in which one child instructs another child in material on which the first is an expert and the second is a novice [29]. [30] defined peer tutoring as a method of teaching which one student (or small group of students) receives personalized and individualized instruction. It is a process by which a pupil (learner called the tutor) with minimal training and with teacher’s guidance helps one or more students at the same grade level (called the tutees) [31]. Peer tutoring is of many models. They include Classwide Peer Tutoring (CWPT), Same-Age Tutoring, Cross-Age Tutoring, Peer-Assisted Learning Strategies (PALS), and Reciprocal Peer Tutoring (RPT) [32].

In Peer Tutoring the topic or theme is divided into subtopics. The teacher selects peer tutors according to number of subtopics and groups. The teacher also trains the peer tutors and assigns each to peer tutoring groups. The peer tutors take turns to teach the subtopics after which the students return to the class and interact to resolve any contentious issues that might arise from group interactions. Peer Tutoring Strategies have been found to tremendously enhance achievement [33], enhance group learning and promote personal effort of science students [34,35].

The vision and practice of jigsaw and peer instruction instructional strategies relate to the Social Interdependence Theory. The theory was developed in 1949 [36]. The theory thrust is that social interdependence exists when individuals share common goals and each individual’s outcomes are affected by the actions of others [36,37], (2013).

The premise of the theory is that “the way that goals are structured determines how individuals interact, which in turn creates outcome” ([36]: 285). The way that people are interdependent defines the overall outcome to the social system. Structuring of goals may result to positive or negative outcomes or neither. Interactions resulting to outcomes are therefore differentiated into positive interdependence and negative interdependence [36,38,39]. [40]: 4] stated that

1. 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.
2. Negative interdependence (competition) typically results in oppositional interaction as individuals discourage and obstruct each other’s efforts to achieve. Negative interdependence exists when individuals’ goal achievements are negatively correlated; each individual perceives that when one person achieves his or her goal, all others with whom he or she is competitively linked fail to achieve their goals.
3. No interdependence (individualistic efforts) typically results to no interaction as individuals work independently without any interchange with each other. When a situation is structured individualistically, there is no correlation among participants’ goal attainments; each individual perceives that he or she can reach his or her goal regardless of whether other individuals attain or do not attain their goals.

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 [40]. 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.

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.

The positive relationships expected among learners in both Jigsaw and Peer Tutoring classrooms are therefore positively linked to the attributes of social interdependence theory, and in particular the positive interdependence aspect. The choice of social interdependence theory as a background theory for the study of the dependence of achievement on Jigsaw and Peer Tutoring strategies is thus justified. Any differences in achievement would be attributed to the relative efficiency and effectiveness of social interdependence of the students when taught using the Jigsaw and Peer Tutoring instructional strategies.

Despite numerous research reports in literature that Jigsaw and Peer Tutoring strategies are effective in enhancing students' achievement, such reports have mostly been centred on their individual effects. There is no literature source known to researchers where the effects of the two strategies were compared. This study therefore compared the effects of the jigsaw and peer tutoring strategies, specifically, Jigsaw IV and Classwide Peer Tutoring strategies on secondary school students' achievement in science.

It has been shown [41] that students' performance in science subjects is gender dependent. Gender is an analytic concept that describes sociological roles, cultural responsibilities and expectations of men and women in a given society or cultural setting [42]. Gender is therefore a social or cultural construct, characteristic behaviours and roles which society ascribes to females and males. This study also determined the relative effects of Jigsaw strategy and Peer Tutoring on students' achievements in science based on gender.

### 1.1. Statement of the Problem

Literature shows that the outputs of science teaching in secondary schools in Nigeria have not been positively related to input and policy specifics of government. As such the set goals have not been met to any meaningful extent. Reports from public examination bodies like the West African Examinations Council (WAEC) indicate that there is poor and declining academic achievement of students in Senior Secondary Certificate Examinations in the sciences. The poor academic achievement in science may be due to many factors including the use of inappropriate instructional strategies.

Studies have shown that science teachers adopted learner-centered instructional strategies in science classes. In particular, despite that science teachers use of peer instructional strategies, the negative trend in achievement in science has not been reversed. The persistent low

achievement may be attributed to failure to decipher strategies that would be more appropriate for science contents based on variables learning outcome. Put in another way, it is not yet evident that science teachers who venture into the use of innovative methods do so in their conviction that such methods have more positive effects on achievements than similar ones. Specifically, science teachers who use Jigsaw or Peer Tutoring strategies may not have empirical bases for preferring one to the other. This needs to be addressed. The problem of this study is therefore, to determine the relative effects of Jigsaw and Peer Tutoring instructional strategies on secondary school students' achievement in science.

### 1.2. Purpose of the Study

The general purpose of the study was to determine the relative effects of Jigsaw and Peer Tutoring instructional strategies on the achievement of secondary school science students. In particular, the study sought to determine:

1. the relative effects of Jigsaw and Peer Tutoring instructional strategies on secondary school students' achievement in science;
2. the effects male gender on male secondary school students' achievement in science when taught science using Jigsaw and Peer Tutoring instructional strategies;
3. the relative effects of female gender on secondary school students' achievement in science when taught using Jigsaw and Peer Tutoring instructional strategies.

### 1.3. Justification of the Study

The findings of the study will be significant to various people: science teachers, science students, senior secondary school authorities and institutions that train science teachers.

Results of the study will enlighten science teachers on the efficacy of Jigsaw and peer tutoring as strategies for teaching science. They will have empirical bases to take informed decisions on which of the strategies to use in science delivery.

One of the challenges of innovative approaches to teaching and learning has to do with acceptability and adaptability by the learners. Learners often show reluctance to adapting of a new approach. Results of the study will provide science students bases to accept and adapt preferentially to the strategies, to improve their achievement.

Institutions that train science teachers will benefit from the result of this study by getting necessary information about the strategies. This will help them adopt the strategies, improve on their knowledge of instructional strategies and facilitate the mentoring of student-teachers in adoption of active learning strategies in science teaching.

The result of the study will be useful to science curricula planners. It will help them in defining appropriate materials and delivery activities necessary for proper implementation of the curriculum, especially developing strategies to improve on the efficiency of the process and application of Jigsaw and peer tutoring in senior secondary science class.

## 1.4. Scope of the Study

The work was delimited to determining the relative effects of Jigsaw and Peer Tutoring instructional strategies on the achievement of science students. The research subjects of the study were SS II chemistry students in selected secondary schools in Abakaliki Education Zone of Ebonyi State Nigeria. The topic taught and assessed was chemical equilibrium. The schools used were those that have qualified regular chemistry teachers with at least B.Sc (Ed)/B.Ed in chemistry educations in SS II class.

## 1.5. Research Questions

The research answered the following research questions:

1. What are the relative effects of Jigsaw and Peer Tutoring instructional strategies on secondary school students' achievement mean scores in science?
2. What are the effects of Jigsaw and Peer Tutoring instructional strategies on male secondary school students' achievement mean scores in science?
3. What are the effects of Jigsaw and Peer Tutoring instructional strategies on female secondary school students' achievement mean scores in science?

## 1.6. Research Hypotheses

The following null hypotheses were tested at 0.05 level of significant:

**HO1:** There is no significant difference between the achievement mean scores of secondary school students taught science using Jigsaw and Peer Tutoring instructional strategies.

**HO2:** There is no significant difference between the achievement mean scores of male secondary school students taught science using Jigsaw and Peer Tutoring instructional strategies.

**HO3:** There is no significant difference between the achievement mean scores of female secondary school students taught science using Jigsaw and Peer Tutoring instructional strategies.

## 2. Research Method

### 2.1. Research Design

The research adopted quasi-experimental design based on pre-test, post-test non-equivalent control group. [43] stated that a quasi-experimental design is one that looks a bit like an experimental design but lacks the key ingredient - random assignment. This design was appropriate for this study because the subjects were made up of two experimental groups where each group was made up of intact classes, and subjects were not assigned randomly. The use of intact classes was for convenience to ensure that classes were treated as groups which were similar in their baseline characteristics.

The design is represented thus:

$$\frac{O_1 \quad X_1 \quad O_2 \quad E_1}{O_1 \quad X_2 \quad O_2 \quad E_2}$$

where  $O_1$  and  $O_2$  are pre-test and post-test respectively.  $E_1$  is experimental group 1 and  $E_2$  is experimental group 2.  $X_1$  and  $X_2$  are Jigsaw strategy for experimental group 1 and Peer Tutoring strategy for experimental group 2 respectively. Gender was a moderator variable in the study.

### 2.2. Area of the Study

The study was carried out in Abakaliki Education Zone of Ebonyi State Nigeria. Ebonyi State is bounded in the North by Benue State, in the South by Abia State, East by Cross River State, and in the West by Enugu State. It is divided into three education Zones (Abakaliki, Onueke and Afikpo Education Zones).

### 2.3. Population of the Study

The population of the study comprised all the SS 2 chemistry students in public schools in Abakaliki Education Zone of Ebonyi State. The choice of this target population was informed by the fact that SS 2 students are not involved in certificate examinations that would interrupt the experimental process. In addition, the topic used for the study (chemical equilibrium) is in the SS 2 chemistry syllabus.

### 2.4. Sample and Sampling Techniques

The sample for the study was made up of SS 2 chemistry students from four secondary schools. Intact chemistry classes, one in of two of the four secondary schools was used for respective instructional strategy.

Purposive sampling technique was used to choose the schools. The criteria used in choosing the schools used were that the school should have a reasonable number of SS 2 Chemistry students and the chemistry teacher must possess at least a B. Sc./B. Ed in chemistry education.

Step-by step simple ballot system was used to arrive at the sample for the study. At the first step simple ballot was used to pick two out of the four local government areas in the zone. Abakaliki and Ohaukwu Local Government Areas (L. G. As) emerged. The second step involved simple ballot by replacement to choose four (4) secondary schools, two from each of Ohaukwu and Abakaliki L. G. As. Schools in each L. G. A. formed an experimental (treatment) group. In the third and final step, simple balloting was used to assign the groups to different treatment groups.

The sample was 202 SS 2 students consisting 91 (52 male and 44 female) in the experimental group 1 (Jigsaw instructional strategy group) and 106 (55 male and 51 female students) for the experimental group 2 (Peer Tutoring instructional strategy).

### 2.5. Instrument for Data Collection

The instrument for data collection was a set of researcher-made science test questions code-named Science Achievement Test (SAT). The instrument was divided into two sections A and B. Section A required information on the bio-data of the research subjects. Section B contained thirty multiple choice questions drawn from chemical equilibrium. Each item had four options

(a, b, c and d) where the research subject was required to choose the correct answer from the options. SAT was used as pre-test and post-test instrument to evaluate the achievement of the students taught using both Jigsaw and Peer Tutoring instructional strategies.

## 2.6. Validation of the Instruments

The initial text of SAT contained 35 items. The instrument was face validated by three experts – two from chemistry education and one from measurement and evaluation. The validators vetted SAT instrument based on content coverage, relevance of the drafted items to stated specific purposes of the study as well as clarity and the level of language to the students. The comments and amendments suggested by the experts were taken into consideration in modifying items. None of the items was dropped.

The 35-item SAT was administered as trial test, with a retest after two weeks, on 30 students in SS 2 in Ikwo High School, Agubia which is in Onueke Educational Zone. The first scores were used for difficulty and discriminating index analysis of the items. By this analysis, five (5) items were dropped. This reduced the number of items to 30. The remaining 30 items were then used to draw a test-blue print which established that SAT was valid content-wise.

## 2.7. Reliability of the Instruments

Data from the trial tests were used to run the Pearson Product Moment Correlation which gave a reliability coefficient of 0.83; the Kuder-Richardson-20 (KR-20) test of internal consistency which gave a coefficient of 0.95; both results showing that SAT was reliable.

## 2.8. Experimental Procedures

The researchers used the permanent chemistry teachers in the sample schools as research assistants, to teach Chemical equilibrium in their respective intact classes. The use of permanent teachers was to make the experimental process conform to normal science lessons of the class and hence, eliminating suspicion by the students which might have affected the reactions of the subjects to the treatments. The treatment lasted for 40 minutes each lesson, two times a week for four weeks or one double period of 80 minutes per week for four weeks based on the convenience of each school's time table.

The research assistants were trained by the researchers on how to implement respective researchers-made instructional procedures and lesson plans for jigsaw and

peer tutoring instructional strategies. The training lasted for a total of 4 hours for each instructional strategy.

## 2.9. Method of Data Collection

SAT was administered on the subjects as pre-test prior to treatment. At the end of the treatment, SAT was administered again as post-test. Before using the instrument as post-test, the items were reshuffled to ensure that the pre-test did not influence the responses of research subjects to the post-test that might result from familiarity with the items.

## 2.10. Method of Data Analysis

Each item in SAT was scored 1 point. The mean and standard deviation of the students' scores were used to answer the research questions. The ANCOVA statistic was used to test the hypothesis 1 (HO1) at 0.05 level of significance. The t-test statistic was used to test HO2 and HO3 at 0.05 alpha level.

## 3. Results

**Research Question 1:** What are the relative effects of Jigsaw and Peer Tutoring instructional strategies on secondary school students' achievement mean scores in science?

Data collected using the achievement test: pretest (PRT) and posttests (POT) of all the students in both the Jigsaw (JGS) and Peer Tutoring (PT) Instructional Strategies groups were used to answer this research question. Summary of results is shown in Table 1.

As shown in Table 1, the pretest mean score of students taught science using the Jigsaw instructional strategy was 9.77, their posttest mean score was 19.38 with 1.90 standard deviation and 9.61 mean gain. The Table also shows that the pretest mean score of students taught science using the peer tutoring instructional strategy was 9.67, their posttest mean score was 18.76 with 1.84 standard deviation and 9.09 mean gain. The results show that Jigsaw instructional strategy yielded greater achievement mean gain score than the Peer Tutoring instructional strategy.

**Research Question 2:** What are the relative effects of Jigsaw and Peer Tutoring strategies on male secondary school students' achievement mean in science?

The data collected on achievement (pre- and posttests) for both the Jigsaw and Peer Tutoring instructional strategies groups for male students only were used to answer this research question. Summary of results is shown in Table 2.

Table 1. Achievement Mean Score of Science Students Based on Teaching Methods

STRATEGY	N	PRT MEAN	SD	POT MEAN	SD	MEAN GAIN
JGS	96	9.77	1.99	19.38	1.90	9.61
PT	106	9.67	1.93	18.76	1.84	9.09

Table 2. Achievement Mean Scores of Male Students in the Jigsaw and Peer Tutoring Groups

STRATEGY	N	PRT MEAN	SD	POT MEAN	SD	MEAN GAIN
JGS	52	9.65	2.09	19.19	1.94	9.54
PT	55	9.36	1.68	18.87	1.68	9.51

Table 2 shows that the achievement mean gain of male science students in the Jigsaw group (9.54) was slightly greater than the mean achievement mean gain for male science students in the Peer Tutoring group (9.51).

**Research Question 3:** What are the effects of Jigsaw and Peer Tutoring instructional strategies on female secondary school students' achievement mean scores in science?

The data collected on achievement (pre- and posttest) of female students in both the Jigsaw and Peer Tutoring instructional strategies groups were used to answer this research question. Summary of results is shown in Table 3.

**Table 3. Achievement Mean Scores of Female Students in the Jigsaw and Peer Tutoring Groups**

STRATEGY	N	PRT MEAN	SD	POT MEAN	SD	MEAN GAIN
JGS	44	9.91	1.88	19.59	1.85	9.68
PT	51	10.00	2.14	18.65	1.82	8.65

Table 3 shows that the achievement mean gain of female science students in the Jigsaw group (9.68) was greater than the mean achievement mean gain for male science students in the Peer Tutoring group (8.65).

#### 4. Research Hypotheses

**HO1:** There is no significant difference between the achievement mean scores of secondary school students taught science using Jigsaw and Peer Tutoring instructional strategies.

Data collected using the achievement test (pre and posttest) for both Jigsaw and Peer Tutoring instructional strategies groups for all students were used to test this hypothesis.

Summary of the results is shown in Table 4.

Table 4 showed that the F-Ratio for methods was 5.573 with significance of F as 0.019. There is significant (S) difference since significance of F (0.019) is less than 0.05. HO<sub>3</sub> was not accepted. This means that there is significant difference between the achievement mean gain of students taught using Jigsaw instructional strategy and those taught using Peer Tutoring instructional strategy.

**HO2:** There is no significant difference between the achievement mean scores of male secondary school students taught science using Jigsaw and Peer Tutoring instructional strategies.

Achievement mean scores of male students in the jigsaw and peer tutoring groups were used to test HO<sub>2</sub> (see Table 5).

The results in Table 5 show that the significance of t(0.337) is greater than the set alpha level(0.05). Therefore, there is no significant (NS) difference between the achievement mean scores of male students taught science using Jigsaw instructional strategy(19.19) and the achievement mean scores of students taught science using peer tutoring(m= 18.84, S.D.=1.81).

**HO3:** There is no significant difference between the achievement mean scores of female secondary school students taught science using Jigsaw and Peer Tutoring instructional strategies.

Achievement mean scores of female students from the jigsaw and peer tutorial groups were used to test HO<sub>3</sub> (see Table 6).

The results on Table 6 show that the significance of t(0.015) is less than the set alpha level(0.05). There is a significant difference between the achievement mean score of female students taught science using Jigsaw instructional strategy (m = 19.59, SD = 1.85) and female students taught using Peer Tutoring instructional strategy (m =18.65, S.D =1.82).

**Table 4: ANCOVA Results of Achievement Mean Based on Methods of Teaching**

Source of variation	Type III Sum of Squares	DF	Mean Square	F	Sig. of F	Decision
Corrected Model	50.363	4	12.591	3.724	0.006	
Pretest	26.431	1	26.431	7.818	0.038	
Intercept	2286.505	1	2286.50	676.3	0.006	
METHOD	18.841	1	18.841	5.573	0.019	S
GENDER	0.000	1	0.000	0.000	0.990	
2-Way Interactions	6.052	1	6.052	1.790	0.182	
Method X Gender	6.058	1	6.052	1.790	0.182	
Error	666.038	197	3.381			
Total	74057.000	202				
Corrected Total	716.401	201				

Method: Significant at p < 0.05.

**Table 5. T-Test Table for Mean Scores of Male Students for Jigsaw and Peer Tutoring Instructional Strategies**

Method	N	Mean	SD	T	Df	Sig of t	DEC.
Jigsaw	52	19.19	1.94	0.965	105	0.337	NS
P T	55	18.84	1.81				

P(0.337) > 0.05, not significant; Accept HO.

**Table 6. T-Test Table for Mean Scores Female Students for Jigsaw and Peer Tutoring Instructional Strategies**

Method	N	Mean	SD	t	df	Sig of t
Jigsaw	44	19.59	1.85	2.49	93	0.015 S
P T	51	18.65	1.82			

P(0.015) < 0.05, significant; Reject HO.

## 5. Summary of Findings

The following is the summary of the findings of the research:

1. Secondary school students taught science using Jigsaw instructional strategy had higher achievement mean score than the students taught using the Peer Tutoring instructional strategy
2. Male students taught science using the Jigsaw instructional strategy had higher achievement mean score than male students taught using the peer tutoring strategy.
3. Female students taught science using the Peer Tutoring instructional strategy had higher achievement mean score than female students taught using the peer tutoring strategy.
4. There is significant difference between the achievement mean scores of students taught science using Jigsaw instructional strategy and those taught using Peer Tutoring.
5. There is no significant difference between the achievement mean scores of male secondary school students taught science using Jigsaw instructional strategy and those taught using the peer tutoring strategy.
6. There is significant difference between the mean achievement scores of female secondary school students taught science using jigsaw instructional strategy and female secondary school students taught using the Peer Tutoring instructional strategy.

## 6. Discussions

The research was designed to determine the relative effects of Jigsaw and Peer Tutoring instructional strategies on secondary school students' achievement in science. Findings of the study showed that Students who were taught science using the Jigsaw instructional strategy made higher achievement than students taught using the Peer Tutoring strategy. The difference was not statistically significant. The high achievement of science students when taught using Jigsaw instructional strategy is in line with the findings of [28] and [25]. The essence of any cooperative strategy is to ensure higher students' achievement by providing teaching and learning environment that incorporates learners' interactions. The greater such interaction and involvement of learners in teaching and learning process the more likely that individual learners will achieve higher and raise the group mean. The higher achievement by the Jigsaw instructional strategy group may be due to the active participation of all the students at every stage of the class which is not applicable in the Peer Tutoring class.

Male students in the Jigsaw group had higher achievement mean score than male students in the Peer Tutoring group. The achievement mean scores were not statistically different. That Jigsaw strategy was apparently superior may be related to greater level of positive interaction between the students under the strategy than in the peer tutoring. Jigsaw instructional strategy provided greater opportunity for peer interactions and inclusiveness in the instructional process due to group and individual

effort moments. This agrees with the postulation of the Social Interdependence Theory that the way that goals are structured determines how individuals interact, which in turn creates outcome [36].

The findings showed that female students in the Jigsaw group had higher achievement mean scores than female students taught using the peer tutoring strategy. The difference was found to be statistically significant. This suggests that the greater interdependence between the learners as a result of active involvement of all the students across the instructional period in the jigsaw classroom favoured female students' achievement. Observations in the class indicate greater tendency of female science students to depend on other learners and the teacher for class activities. The nature of activities in a jigsaw class provides female students greater field of interaction with other learners, and hence increasing self-confidence and determination to achieve. This agrees with the view of the Social Interdependence Theory that Positive interdependence exists when collaborators engage in promotive interactions (i.e. helping, sharing, encouraging) [40]. On the contrary, the setting in a peer tutoring class appears like in a teacher-centred class except that the tutor is a peer of the learners. The level of interaction in a peer tutoring class is therefore lower than in the jigsaw class, resulting to lower interdependence and lower achievement of students taught using the peer tutoring instructional strategy.

## 7. Implications of Findings

1. Science teachers should use Jigsaw instructional strategy more than Peer Tutoring strategy since students taught using Jigsaw strategy had higher achievement mean score, which was significantly different, than those taught using Peer Tutoring strategy.
2. Science teachers could use either of the strategies in males-only science classes as both yielded achievement mean scores that are not significantly different.
3. In teaching science, science teachers could prefer jigsaw instructional strategy to peer tutoring strategy in females-only science classes since female students taught science using peer tutoring instructional strategy.

## 8. Conclusion

Jigsaw and Peer Tutoring instructional strategies enhance students' achievement in science. Both are therefore appropriate for effective instruction in science classroom. The findings of the study show that the Jigsaw instructional strategy yielded higher achievement mean scores than the Peer instructional strategy and the difference is statistically significant. None of the strategies was gender biased. However, that female science students' significantly greater achievement mean score when taught using the jigsaw instructional strategy implies that the strategy could be preferred in female-only classes. It is therefore evident that science teachers should use the Jigsaw instructional strategy more often than the Peer

Tutoring strategy. However both strategies can be used irrespective of the gender of the science students.

## 9. Recommendations

Based on the findings of the study, the researcher recommends as follows:

1. Science teachers should make use of the Jigsaw instructional strategy to enhance students' achievement in science.
2. Colleges and universities that train science teachers should emphasis the training of teachers to improve in the use of peer instruction strategies, with more emphasis on jigsaw instructional strategy.
3. Curriculum planners should incorporate into curriculum guides, appropriate content areas where the peer instruction strategies, especially the jigsaw instructional strategy can be used.

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