# Jigsaw Cooperative Learning, Simulation Games, Lecture Method and Students' Retention of Physics Knowledge in Delta State

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***Abstract***
*The primary objective of this study was to investigate the effect of three different instructional methods, specifically jigsaw cooperative learning, simulation games and lecture method, on the long-term retention of physics knowledge among students in Delta State. This study was conducted based on two hypotheses. The research utilised a quasi-experimental design. The research included a population size of 18,879 SSII Physics students who were currently enrolled in public senior secondary schools situated in Delta State. The research included a sample size of 321 students. The participants in the study were chosen by a simple random selection technique. The data collection tool utilised was a Physics Achievement Test (PAT) that was designed by the researcher. The PAT completed a comprehensive validation process, which encompassed many rigorous processes such as face, content and construct validation. Furthermore, the reliability of the PAT was found to be high, as evidenced by a coefficient of 0.79. The collected data underwent analysis utilising ANOVA and ANCOVA statistics. The study's results showed that there was a statistically significant difference in the average retention scores of physics among students who received instruction through the jigsaw cooperative learning, simulation games and lecture method. The results of the study indicate that students who received instruction through the implementation of the jigsaw cooperative learning and simulation games had superior retention scores in comparison to their peers who received instruction through lecture method. Moreover, the conducted research did not yield a statistically significant interaction between the teaching method and the sex of the students in terms of their ability to retain knowledge in the field of physics. It was recommended that secondary school physics educators should contemplate including jigsaw cooperative learning and simulation games into their pedagogical approaches for the study of physics.*

***Keywords:*** *Jigsaw cooperative learning, simulation games, lecture method, students' retention of physics knowledge*

## Introduction

Physics is a scientific subject concerned with the investigation of matter, energy and their mutual interactions. The objective of this field of study is to comprehend the underlying principles and regulations that dictate the dynamics of the cosmos, encompassing both the microscopic and macroscopic realms. Physics spans a diverse range of sub-disciplines, including classical mechanics, electromagnetic, thermodynamics, quantum mechanics and relativity, among other areas of study. It involves observing, modeling, and experimenting to develop theories and

explanations for phenomena observed in nature. Physics plays a crucial role in advancing technology, engineering, and other scientific disciplines. The discipline of physics offers a robust basis for anyone aspiring to engage in advanced academic pursuits within the realms of science, engineering, or technology-oriented disciplines. The curriculum provides students with the necessary abilities in critical thinking, problem-solving, and analysis, which are vital for achieving success in these respective disciplines. Nigeria is actively endeavouring to make advancements in the fields of science and technology. The field of physics plays a pivotal part in the acquisition and cultivation of the essential knowledge and abilities that are crucial for the progression of technological developments. By studying physics, students can contribute to scientific research and innovation, which can ultimately lead to economic development in the country.

As outlined by Asogwa, Muhammed, Asogwa, and Ofoegbu (2016), the specified aims for the instruction of physics at the secondary school level in Nigeria are as follows. The main aim of this subject is to impart students with a comprehensive comprehension of fundamental physics ideas, principles, theories, and laws. This encompasses a comprehensive understanding of diverse disciplines within the field of physics, including mechanics, thermodynamics, electricity, magnetism, optics, and current physics. Physics education aims to develop students' problem-solving skills and encourage critical thinking. Students should be able to analyze and solve physics problems using logical reasoning, mathematical calculations, and scientific methods. Teaching physics involves conducting experiments and practical activities to enable students to understand and apply theoretical concepts. It focuses on developing skills in experimental design, data collection and analysis, and drawing conclusions from experimental results. Physics education encourages students to develop scientific inquiry skills by formulating questions, designing investigations, and conducting research. This objective aims to stimulate curiosity, creativity, and the ability to investigate real-world phenomena. Physics education should connect classroom learning to real-life situations, emphasizing the application of physics principles in everyday life, technology, and industry. This helps students understand the relevance of physics and its impact on society. Teaching physics aims to develop students' scientific literacy, enabling them to understand and critically evaluate scientific information, theories, and their implications. This objective promotes the ability to make informed decisions and participate in scientific discussions. Physics education provides a foundation for students interested in pursuing careers in scientific research, engineering, technology, medicine, and other related fields. It equips students with the necessary foundation to pursue advanced studies in physics or other related fields at the post-secondary level.

The attainment of physics teaching objectives is highly dependent on the teacher's choice of teaching method. The teaching method chosen by the teacher plays a crucial role in how effectively the students can understand and apply the concepts of physics. The selection of the teaching method by the educator can significantly influence the level of student engagement in the educational endeavour. If the method is interactive and hands-on, it can keep the students actively involved, promoting better understanding and retention of the subject matter. Various teaching methods accommodate diverse learning styles and student preferences. Certain students may exhibit enhanced learning abilities when exposed to visual assistance, whereas others may manifest heightened learning outcomes when provided with verbal explanations or engaged in kinesthetic activities. A teacher's choice of teaching method should consider the diverse learning styles of the students to ensure maximum comprehension and concept retention. Retention refers to an

individual's capacity to retain and retrieve knowledge, materials and experiences that have been acquired and learned over a period of time. The retention of acquired information within the mind necessitates its preservation in the form of visual imagery in order to facilitate the development of knowledge. According to Morris (2014), the occurrence of a stimulating setting leads to the revival or reproduction of preserved pictures. This is why it is imperative to deliver physics concepts to learners in a manner that engages their subconscious, hence facilitating rapid recall of the concepts being taught or learned. This study aimed to perform a comparative analysis of teaching methods, including jigsaw cooperative learning, simulation games and the lecture method, with the objective of identifying the most effective method for improving students' retention of physics knowledge.

The jigsaw cooperative learning strategy is a teaching and learning technique that involves breaking a larger learning task or topic into smaller parts, and then assigning each part to a group member (Babagana, Yaki & Idris, 2016). Each member assumes the role of an expert within their designated subtopic and thereafter engages in collaborative efforts with members from other groups who have also been allocated the same subtopic, in order to exchange and disseminate their respective areas of expertise. Ultimately, every member of the group has acquired knowledge pertaining to the various subtopics addressed by the remaining groups. The utilisation of the jigsaw technique facilitates the cultivation of cooperation, active engagement and peer instruction. The approach fosters student participation in the educational process, facilitates the cultivation of communication and collaboration abilities, and facilitates the acquisition of a more profound comprehension of the subject matter under examination. The Jigsaw cooperative learning approach is an instructional framework that promotes dynamic engagement of students, collaborative interactions and the development of constructive interdependence in a classroom environment. The process entails the segmentation of a multifaceted subject matter or undertaking into more manageable components or subtopics, which are subsequently allocated to individual cohorts of students. Every group assumes the role of a "expert" in their designated area of study, thereafter imparting knowledge to their peers in other groups. This jigsaw cooperative learning has the potency to enhance students' retention of physics (Nduji, Nwandikor, Keziah & Elejere, 2020). Jigsaw encourages active engagement as students have to take ownership of their assigned part and explore it in-depth. This active involvement promotes deeper understanding and increases the likelihood of knowledge retention. Jigsaw promotes collaboration and teamwork among students. Working together to become an expert and then teaching their peers fosters a sense of shared responsibility and encourages a deeper understanding of the material. Thus, will the use of jigsaw cooperative learning enhance students' retention of physics than simulation games? Answering this question is one of the rationales for the study.

According to Ayuba and Timayi (2018), simulation games are video games or computer-based activities that are designed to provide educational content and simulate real-world scenarios. The games encompass a diverse array of subjects, spanning from scientific and mathematical disciplines to historical and linguistic domains. Educational simulation games usually aim to engage learners in active learning, problem-solving, critical thinking, and decision-making skills. They provide an interactive and immersive environment that allows players to explore and understand complex concepts in a hands-on and engaging way. Some popular examples of educational simulation games include MinecraftEdu, SimCity, Civilization series, and Kerbal Space Program. Educational simulation games are a great tool for promoting student retention and deepening their understanding of various subjects (Bahrami, Chegiru, Kianzadeh, Emami & Abdi,

2012). Simulation games facilitate active learning by providing students with the opportunity to actively engage in the educational process. They can explore concepts, make decisions, and experience the consequences of those decisions. This hands-on approach helps students retain information better than passive learning methods. Educational games are designed to be highly engaging and interactive, capturing students' interest and attention. When students are actively involved in the educational process, their likelihood of recalling and retaining the knowledge they receive during gameplay is increased. Thus, will the use of simulation games enhance students' retention of physics knowledge than the lecture method? Answering this question is another rationale for the study.

The lecture method is a traditional teaching method where the instructor delivers information or a presentation to the students in a formal manner (Tran, 2014). It is primarily a one-way communication method, where the instructor typically speaks for an extended period of time while the students listen and take notes. The lecture method can involve the use of visual aids like slides or handouts to support the presentation. The lecture method is one of the traditional methods of teaching, where the instructor delivers information to a large group of students. While this method is widely used, it has both advantages and challenges when it comes to student retention. Lectures provide students with the opportunity to learn from experts in the field. This can facilitate their acquisition of a full comprehension of the topic matter. Lectures usually cover a wide range of relevant content, allowing students to get an overview of the topic. Lectures often follow a structured format, which helps students to organize and retain information. Thus, the use of the lecture method equally has the potency to enhance students' retention of physics knowledge.

The effectiveness of some teaching method may be dependent on students' sex. The effect of a particular pedagogical method on the retention rates of male and female students may exhibit disparities. In today's society, it is crucial to promote gender equality. A teaching method that benefits one sex more than the other would perpetuate sex disparities, which goes against the principles of fairness and equality. Thus, this study aimed to investigate whether the effectiveness of jigsaw cooperative learning, simulation games and lecture method is influenced by sex.

**Statement of the Problem**

Physics is an important discipline that requires a comprehensive understanding of complex concepts, critical thinking skills, and practical application. Traditional lecture-oriented classroom settings may not effectively engage students in the learning process, resulting in lower levels of retention of physics. Therefore, alternative teaching method, such as jigsaw cooperative learning, simulation games, have emerged as potential methods to promote active student involvement and deeper understanding of physics concepts. Therefore, the problem is: will jigsaw cooperative learning, simulation games enhance students' retention of physics knowledge more than the lecture method?

**Purpose of the Study**

The purpose of this study was to evaluate and compare the efficacy of three different teaching methods - jigsaw cooperative learning, simulation games and lecture - in terms of their effect on students' retention of physics knowledge. The study aimed to identify and recommend the most successful teaching method among these three methods. The study was specifically designed to ascertain:

1. the disparity in average retention scores between students who were instructed in physics through jigsaw cooperative learning, simulation games and lectures; and

2. the interaction effect of treatment and sex on students' physics retention.

**Hypotheses**

The following null hypotheses guided this study:

**$HO_1$:** There is no statistically substantial difference in average retention scores between students taught physics utilising jigsaw cooperative learning, simulation games and the lecture method.

**$HO_2$:** There is no substantial interaction effect between teaching method and sex on students' retention of physics.

**Methodology**

The research utilised a quasi-experimental design. The study encompassed a population of 18,879 SSII Physics students enrolled in public senior secondary schools located in Delta State. The study utilised a sample of 321 students studying Physics in six schools, selected by the simple random sampling procedure. The data collection instrument employed in this study was a Physics Achievement Test (PAT) that was developed by the researcher. To ensure the validity of the PAT, expert judgement was sought from two lecturers. Additionally, an experienced Physics teacher was also involved in the validation process. The determination of the content and construct validities of PAT was also conducted. The reliability of the PAT was determined by the utilisation of the Kuder-Richardson 21 coefficient. The administration of the PAT was conducted on a sample of 30 students who were not directly involved in the study field. Subsequently, the reliability index of the test was computed. The instrument's reliability coefficient was determined to be 0.79. The instructional treatment consisted of delivering physics instruction to students in several groups, covering the following topics: (i) The production and propagation of waves; (ii) Different forms of waves; (iii) Properties associated with waves; and (iv) Light waves. This was accomplished through the use of jigsaw cooperative learning, simulation games and the lecture method. Prior to the implementation of the treatment, pretests were delivered to the participants. Subsequently, posttests were conducted to assess the effects of the treatment. The delayed posttest, often known as the retention test, was conducted four weeks following the treatment. The collected scores were subjected to analysis of variance (ANOVA) and analysis of covariance (ANCOVA) for further examination and interpretation.

**Results**

**$HO_1$:** There is no statistically substantial difference in average retention scores between students taught physics utilising jigsaw cooperative learning, simulation games and the lecture method.

**Table 1**

**ANOVA Comparison of Student Retention Scores in Jigsaw Cooperative Learning, Simulation Games and Lecture Groups**

| | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Between Groups | 13899.745 | 2 | 6949.872 | 66.485 | .000 |
| Within Groups | 33241.551 | 318 | 104.533 | | |
| Total | 47141.296 | 320 | | | |

Table 1 shows a statistically significant disparity in the average retention scores observed among students who were instructed in physics through the utilisation of jigsaw cooperative learning, simulation games and the lecture method. This difference is supported by the statistical analysis, as evidenced by the significant F-value of 66.485, with degrees of freedom (2,318) and p-value of 0.000 less than 0.05. Therefore, the null hypothesis is rejected. Hence, a significant disparity exists in the average retention scores observed among students who were instructed in physics through the utilisation of jigsaw cooperative learning, simulation games and the lecture method. The determination of the direction of the difference was conducted with Scheffe's post-hoc test, as illustrated in Table 2.

**Table 2**

**Analysis of the Retention Effects of Jigsaw Cooperative Learning, Simulation Games, and the Lecture Method Using Scheffe's Post-hoc Test**

| (I) Teaching methods | (J) Teaching methods | Mean Difference (I-J) | Std. Error | Sig. | 95% Confidence Interval Lower Bound | Upper Bound |
|---|---|---|---|---|---|---|
| Jigsaw | Simulation | 1.079 | 1.456 | .760 | -2.50 | 4.66 |
| | Lecture | 14.080* | 1.405 | .000 | 10.62 | 17.53 |
| Simulation | Jigsaw | -1.079 | 1.456 | .760 | -4.66 | 2.50 |
| | Lecture | 13.000* | 1.358 | .000 | 9.66 | 16.34 |
| Lecture | Jigsaw | -14.080* | 1.405 | .000 | -17.53 | -10.62 |
| | Simulation | -13.000* | 1.358 | .000 | -16.34 | -9.66 |

Table 2 demonstrates that the average retention scores of students instructed in physics through jigsaw cooperative learning do not differ significantly from those instructed through simulation games. However, a significant difference does exist between the average retention scores of students instructed in physics through jigsaw cooperative learning, simulation games and lecture method, which favours students instructed in physics via jigsaw cooperative learning and simulation games. Table 2 shows that students taught using jigsaw cooperative learning and simulation games had greater average retention scores than those taught using lectures.

**$HO_2$:** There is no substantial interaction effect between teaching method and sex on students' retention of physics.

**Table 3**

**Summary of ANCOVA on Interaction Between Teaching Method and Sex on Students' Retention**

| Source | Type III Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Corrected Model | 2993.669[a] | 6 | 498.945 | 3.242 | .004 |
| Intercept | 19597.954 | 1 | 19597.954 | 127.346 | .000 |
| Methods | 1371.990 | 2 | 685.995 | 4.458 | .012 |
| Sex | 85.238 | 1 | 85.238 | .554 | .457 |
| Methods * Sex | 233.716 | 2 | 116.858 | .759 | .469 |

| | | | |
|---|---|---|---|
| Error | 48323.141 | 314 | 153.895 |
| Total | 922632.000 | 321 | |
| Corrected Total | 51316.810 | 320 | |

In Table 3, the interaction effect of teaching method and sex on physics retention is not statistically significant ($F(2, 314) = 0.759$, $P(0.469) > 0.05$). Thus, the null hypothesis stands. Thus, the results show no statistically significant interaction between teaching method and student sex on physics retention.

**Discussion**

The study found a statistically significant difference in average retention scores among physics students taught via jigsaw cooperative learning, simulation games and lectures. Scheffe's post-hoc test showed no statistically significant difference in the average retention of students taught physics using jigsaw cooperative learning and simulation games. The average retention scores of physics students taught utilising jigsaw cooperative learning, simulation games and lectures varied significantly. The jigsaw cooperative learning and simulation games benefit from this distinction. The post-hoc test showed that students taught physics via jigsaw cooperative learning and simulation games retained physics better than their counterparts taught with lectures. Specifically, jigsaw cooperative learning and simulation games improved average retention scores compared to lecture.

The effectiveness of jigsaw cooperative learning and simulation games can be attributed to the active engagement of students in the instructional process. Jigsaw cooperative learning and simulation games facilitate the active engagement of students as participants during instruction. Students' active involvement facilitated retention of taught physics contents. But this is not the case for the lecture method that encourages students' passivity during instruction. Students' active participation during instruction to some extent aid remembering of learnt concepts. This outcome is consistent with the perspectives presented by Tran (2014) as well as Nwankwo and Okigbo (2021). According to Tran (2014), there was a notable disparity in the achievement and knowledge retention posttest scores between students who received instruction using cooperative learning and those who were taught utilising lecture-based teaching. Nwankwo and Okigbo (2021) found that the implementation of the jigsaw teaching strategy resulted in a considerable improvement in both accomplishment and retention scores among SS2 students in the field of chemistry, surpassing the outcomes achieved by the standard lecture method. This discovery provides additional support to the findings of Ayuba and Timayi (2018), who observed that students who received computer game-based training demonstrated superior recollection of algebraic word problems in comparison to their peers who were instructed by traditional lecture methods.

The findings of the study reaffirm the absence of a statistically significant interaction effect between teaching method and sex in relation to students' retention of physics. This suggests that the effect of students' sex on their recall of physics is not influenced by the teaching method. This finding is consistent with the study conducted by Eze and Lasisi (2018), which found that the interaction between teaching method and sex did not have a significant effect on students' academic achievement and retention in the subject of basic technology.

**Conclusion**

The study concluded that jigsaw cooperative learning and simulation games enhance students' retention of Physics knowledge more than the lecture method. The study again concludes that, putting sex into consideration, jigsaw cooperative learning, simulation games and lecture method did not have more intense effect on students' retention of physics concepts.

**Recommendations**

The study put forth the following recommendations:

1. It is recommended that physics educators incorporate the implementation of jigsaw cooperative learning into their instructional practises at the senior secondary school level. This approach aims to promote increased student engagement and participation during the teaching and learning process in the field of physics.
2. Simulation games can serve as a viable instructional approach in situations where the implementation of jigsaw cooperative learning is impractical.
3. Physics educators should actively promote the utilisation of small group learning strategies to foster an engaged learning environment within the classroom.

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