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Effects of Jigsaw Cooperative Learning and Simulation Games on Students' Achievement in Physics in Delta State

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Abstract: *Delta State students' physics performance was examined using jigsaw cooperative learning and simulation games. Quasi-experimental design was used. The survey included 18,879 Delta State public senior secondary school SSII Physics students. 321 SSII Physics students from six schools were randomly sampled. The researcher's face, content and construct validated Physics Achievement Test (PAT) was used to collect data. ANCOVA analyzed data. The results showed that: students taught using jigsaw cooperative learning, simulations and lecture method had significantly different physics means achievement scores, favouring jigsaw and simulation games; and the interaction effect of teaching method and sex on students' physics achievement was significant. Physics teachers at secondary schools should use jigsaw cooperative learning and simulation games to teach physics, but they must ensure that both sexes actively engage.*

Keywords: Jigsaw cooperative learning, simulation games, lecture method, academic achievement

Introduction

Every nation wants science and technology advancement, including Nigeria. Science and technology determine a nation's progress. Developed nations have advanced scientifically and technologically. Science and technology require physics education. According to Farinde, Ehimetalor, and Dada (2017), physics studies matter and energy interactions. Physics measures. Thus, physics fundamentals are essential for national technology development. Secondary schools teach physics to generate young scientists who can design technology equipment to make daily life easier and more comfortable. Thus, technology relies on physics. Physics education is crucial to Nigeria's technological progress (Jegede & Adedayo, 2013). Competent teachers should organise classroom activities that encourage students to actively learn by interacting with the environment (Caine, 2012). These exercises should be fun and age-appropriate so students may use their whole brain and succeed academically.

However, most physics teachers use the teacher-centered traditional lecture style to cover huge content areas, educate large numbers of students, and cover the scheme of work. The lecture approach, according to Ojediran, Oludipe, and Ehindero (2014), involves the teacher teaching and the students listening and taking notes. The teacher talks most of the time, covering many topics but not comprehending the concepts behind problems. Lectures are mostly deductive, not inductive. Students passively listen to the teacher. Students' performance in those ideas suffers. Thus, Nigerian science education research has sought relevant approaches to teach physics and other science concepts. Despite physics' relevance, students' performance has remained poor, necessitating the quest for new approaches to make physics more meaningful.

The WAEC Chief Examiner's Report states that from 2007 to 2012, less than 40% of physics students received credit passes. From 2013 to 2018, credit pass and above rates increased annually. In 2013, 1,648,363 students registered, with 51.73% (852,699 students) earning credit passes or higher. 57.42% of 1,365,384 students in 2014 earned credit passes, up from 56.42% in 2013. In 2014, 766,936 students made credit pass or above, compared to 852,699 in 2013. 2015–2020 shows this tendency. According to the Chief Examiner, the number of students earning credit passes and above rises one year and falls the following. Many worries about students' physics performance. Asogwa, Muhammed, Asogwa, and Ofegbu (2016) argued that physics students' poor academic performance requires a closer look at the subject's teaching.

Academic achievement measures student learning. Omachi (2010) defines achievement as a student's current academic position. Academic achievement is the demonstration of subject-specific knowledge and skills. Academic success requires effort and skill. Exams or continual assessment test this cognitively. Learning and academic success boost national growth. Since schools are expected to affect society, parents, instructors, and students care about academic accomplishment.

Okoye (2012) indicated that active engagement during education improves learning. Thus, to assess learning outcomes, treatments should be modified. This could improve school physics instruction. Research established various student-centered teaching practises to increase student engagement. These include cooperative, collaborative, discovery/inquiry-based among others. These active learning tactics are better than lectures. Active learning helps students remember and apply course material in different contexts (Pierre, 2011). Jigsaw cooperative learning and simulation games can engage students in physics lessons. Based on this, the researcher wanted to employ jigsaw cooperative learning and simulation games to teach selected physics topics and compare their impacts to those of standard lecture. Jigsaw cooperative learning technique involves jigsaw exercises. Elliot Aronson, a social psychologist, designed jigsaw in 1971 (Aroson, 2005). It organises students into "Jigsaw" groups for instruction. In a jigsaw group, each student completes a task/topic. The teacher lets students from different jigsaw groups with the same task work together in expert groups. After that, the initial jigsaw group members give their information and let the others to ask questions. The group leader then

sums up each group's presentations. The teacher monitors progress, answers questions, and evaluates jigsaw cooperative learning resources.

Each student piece completes the puzzle. Each learner is essential to understanding the concept. Jigsaw learning stimulates students to accomplish challenging and engaging activities in their expert groups because they are the only ones with that information (Babagana, Yaki & Idris, 2016). Tutors must comprehend and explain. Hanze and Berger (2007) discovered jigsaw cooperative learning increases academic performance. Jigsaw cooperative learning accelerates learning and improves objective test scores (Aronson, 2005). In academic endeavours, jigsaw group members promote listening, involvement, and empathy.

However, a simulation game mixes game elements like competitiveness, cooperation, rules and players with simulation elements like including important elements of reality. Simulation game strategy immerses students in a teacher-created universe (Okonkwo, 2012). Students interact in the simulation, which the teacher controls and uses to achieve instructional goals. Simulation games teach students how to gather and organise information and accept others' opinions without bias. Simulation-games also assist students remember what they studied because they need active student participation. De-briefing must be well-planned, reasonable and imaginative (Umo, 2001). It promotes experiential learning by seeking participants' experiences and sharing the teacher's ideas. It also balances learning-related cooperation and conflict. Obeka (2007) suggested that teachers use simulation games to help students learn, rather than just lecturing.

Some teaching styles affect academic performance by sex, according to research. Sex distinguishes men from women (Bland, 2013). Sex is universally biological. The number of studies on sex interference with science education approach has continued to rise. According to Babajide (2010), educators view science, particularly physics, as male. However, good teaching approaches boost scientific student performance regardless of gender (Usang & Okoli, 2021; Akachukwu & Okoli, 2021). Some academics believe male students perform better than girls when exposed to certain teaching approaches, while others believe the opposite. Given the aforementioned, sex interaction with teaching style, particularly in respect to physics student achievement, remains unresolved. Thus, this study investigated the interplay of jigsaw cooperative learning, simulation games, and sex on physics students' academic performance. The study investigated how jigsaw cooperative learning and simulation games affect Delta State students' physics achievement.

Statement of the Problem

The Chief Examiner's Reports show that physics teachers' techniques seriously impact students' performance. Such methods may hinder students' learning of physics ideas, functionality, and application. The WAEC Chief Examiners have observed that WASSCE students struggle with physics. The reports also demonstrate a general lack of accomplishment in the subject, suggesting that physics teachers should look for other teaching approaches to assist students improve. Thus, active learning approaches may be more effective than lectures. The researcher suggested that jigsaw cooperative learning and simulation games could improve students' physics performance more than the lecture technique since they increase student engagement. Thus, will jigsaw cooperative learning and simulation games help physics students' achievement more than lectures?

Purpose of the Study

The study compared jigsaw cooperative learning, simulation games, and lecture approach on physics students' academic performance to find the best one. To determine:

1. difference in mean achievement scores between students taught physics utilising jigsaw cooperative learning, simulation games and lecture method;
2. interaction effect of treatment and sex on physics academic achievement.

Hypotheses

Two hypotheses led this study:

1. There is no significant difference in mean achievement scores between students taught physics utilising jigsaw cooperative learning, simulation games and lecture method;
2. There is no significant interaction effect of treatment and sex on students' achievement in physics.

Methods

Quasi-experimental design was used. The study included 18,879 Delta State public senior secondary school SSII Physics students. The study used a basic random sample of 321 SSII Physics students from six schools. The researcher's Physics Achievement Test (PAT) was face validated by two lecturers: one Science Educator in Physics and an expert in Measurement and Evaluation at Delta State University, Abraka, and one experienced Physics teacher from Otibio Grammar School, Otibio. Also determined were PAT's content and construct validity. PAT reliability was established using the Kuder-Richardson formula 21. The reliability index was calculated by administering PAT 30 Physics students outside the study area. 0.79 was the instrument's reliability coefficient. Using jigsaw cooperative learning, simulation games,and lectures, students in different groups learned about wave production and propagation, wave kinds, wave attributes and light waves. Pretests and posttests were given before and after therapy. The scores were analysed using ANCOVA.

Results

- There is no significant difference in mean achievement scores between students taught physics utilising jigsaw cooperative learning, simulation games and lecture method.

Table 1

Summary of ANCOVA Analysis of Achievement Scores of Students Taught Physics Using Jigsaw Cooperative Learning, Simulation games and Lecture Method

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	6202.704[a]	3	2067.568	19.720	.000
Intercept	116510.946	1	116510.946	1111.259	.000
Pretest	5.408	1	5.408	.052	.820
Methods	6193.525	2	3096.762	29.536	.000
Error	33236.143	317	104.846		
Total	1107714.000	321			
Corrected Total	39438.847	320			

Table 1 reveals that students taught physics via jigsaw cooperative learning, simulation games and lecture approach had significantly different posttest mean achievement scores, $F(2,317) = 29.536$, $P(0.000) < 0.05$. Thus, jigsaw cooperative learning, simulation games and lecture methods provide significantly different mean achievement scores in physics. Scheffe's post-hoc test (table 2) determined the difference's direction.

Table 2

Summary of Scheffe's Post-hoc Test Comparison of Jigsaw Cooperative Learning, Simulation Games and Lecture Method on Achievement

(I) Teaching methods	(J) Teaching methods	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b] Lower Bound	Upper Bound
Jig-saw	simulation	.065	1.459	.964	-2.806	2.936
	Lecture	9.070*	1.408	.000	6.300	11.840
simulation	Jig-saw	-.065	1.459	.964	-2.936	2.806
	Lecture	9.005*	1.361	.000	6.328	11.682
Lecture	Jig-saw	-9.070*	1.408	.000	-11.840	-6.300
	simulation	-9.005*	1.361	.000	-11.682	-6.328

Table 2 shows that students taught physics using jigsaw cooperative learning and simulation games have higher mean achievement scores than those taught using the lecture method ($P(0.000) < 0.05$). However, insignificant difference exists between the mean achievement scores of students taught using jigsaw cooperative learning and simulation games. As shown in table 2, jigsaw cooperative learning and simulation games improve physics learning more than lectures.

- There is no significant interaction effect of treatment and sex on students' achievement in physics.

Table 3

Summary of ANCOVA Analysis on Interaction Effect

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	8777.697[a]	6	1462.950	14.982	.000
Intercept	116178.763	1	116178.763	1189.784	.000
Pretest	.935	1	.935	.010	.922
Methods	6447.887	2	3223.943	33.016	.000
Sex	7.884	1	7.884	.081	.776
Methods * Sex	2573.592	2	1286.796	13.178	.000
Error	30661.150	314	97.647		
Total	1107714.000	321			
Corrected Total	39438.847	320			

Table 3 shows that teaching method and sex interact to affect physics achievement, $F(2, 314) = 13.178$, $P(0.000) < 0.05$. Thus, teaching method and sex have a large interaction effect on physics achievement. Figure 1 shows the interaction plot.

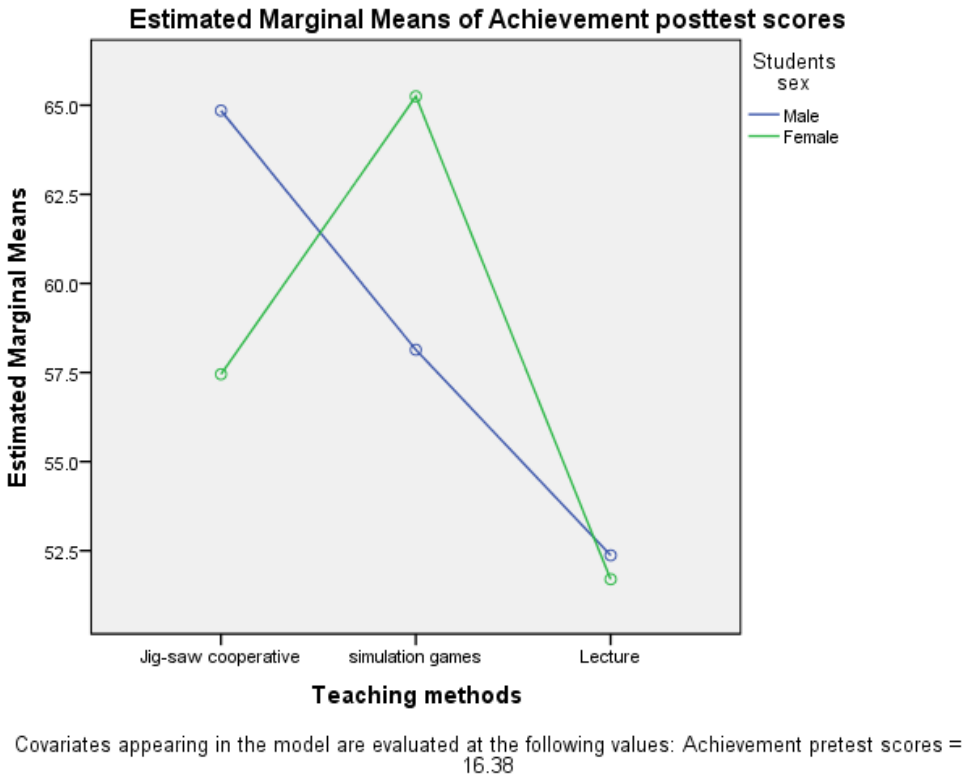

Fig. 1: Plot of Interaction Between Teaching Method and Sex on Achievement

Figure 1 reveals a substantial interaction between teaching method and sex on physics achievement. This implies that students' sex increased the instructional method's influence. As seen in figure, simulation games had a greater impact on students' physics grades when sex was considered.

Discussion

The study found a substantial difference in mean achievement scores between students taught physics utilising jigsaw cooperative learning, simulation games and lecture. The Scheffe's post-hoc test showed no significant difference between the mean achievement scores of students who were taught physics using jigsaw cooperative learning and simulation games, but there was a significant difference between students who were taught physics using jigsaw cooperative learning, simulation games and lecture method, favouring both. The post-hoc test showed that jigsaw cooperative learning and simulation games improve physics learning more than lectures.

This may be due to students' active participation in the learning process. Physics students that used jigsaw cooperative learning and simulation games may have been more engaged in the learning process. Active learning improves learning, according to Ajaja (2013). In jigsaw cooperative learning and simulation games, lecture group students may have been less active. The lecture method's main drawback is students' passive learning. In this study, lecture-taught Physics students had low achievement scores. According to Babagana, Yaki, and Idris (2016), biology students taught using computer simulation and jigsaw methodology outperformed those taught using lecture. This contradicts Gocer (2010), who found no significant difference in mean achievement scores between students taught utilising jigsaw approach and standard lecture method.

The study also found that teaching approach and sex interact to affect physics students' performance. Simulation games affect physics performance by interacting with students' sex. Simulation games may have pique students' interest in one sex over the other. Thus, one sex group enjoys simulation games more than the other. Female students' mean achievement scores are affected more by simulation games than male students. According to Ajaja (2013), cooperative learning and students' sex had no significant effect on biology achievement. This is consistent with Ani, Obodo, Ikwueze, and Tafi (2021), who found a substantial interaction impact of treatment (computer simulation) and gender on Basic Science students' academic performance.

Conclusion

The study concluded that: jigsaw cooperative learning, simulation games and lecture method have the potency to improve students' academic achievement, but jigsaw cooperative learning and simulation games improve achievement more than lectures. The study again finds that simulation games affect physics students' academic performance more when students' sex is considered.

Recommendations

The study's results and conclusion led to these recommendations:

1. Senior secondary school physics teachers should use jigsaw cooperative learning to engage students in the learning process. Meanwhile, physics teachers must ensure equal participation of both male and female students. In fact, more attention should be geared towards female students during instruction using jigsaw cooperative learning.
2. Senior secondary school physics teachers should employ simulation games to simplify and clarify subjects. Meanwhile, effort should be put into place to ensure male students participate as much as female students during classroom instruction.
3. 3. Physics instructors should use the lecture method when using simulation games and jigsaw cooperative learning is not possible, but they should make sure that physics concepts are thoroughly explained with concrete examples and that students have the chance to ask questions while receiving instruction.
4. Physics teachers should encourage students learning in small groups.

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