Innovations

Comparative Effects of Play-Simulation and Analogy Teaching Strategies on Secondary School Chemistry Students' Achievement

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Abstract
The study measured the impact of play simulation and analogy on secondary school chemistry students in Delta North Senatorial District through critical assessment of three research questions and three hypotheses at the 0.05 level of significance. The study also applied a non-randomized pretest-posttest control group design. There were 153 secondary schools with 11,756 SS2 chemistry pupils. From there, the selection of 9 secondary schools and 258 students were employed in the study. The Chemistry Achievement Test (CAT) was utilized to collect data. To assess instrument dependability, the Kuder-Richardson formula 21 yielded reliability co-efficient of 0.86. The t-test was employed to assess the null hypotheses while mean and SD was used to answer all required questions. The results showed a substantial difference in mean chemistry achievement scores between students taught with play simulation and analogy at p<0.05. There was also a significant difference (p<0.05) in mean accomplishment scores between chemistry students taught using play simulation and those taught using lecture, and between chemistry students taught using analogy and those taught using lecture. Based on these data, students taught with Play simulation outperformed students taught with analogy and lecture. Thus, play simulation improves students' achievement in chemistry.

Introduction

One of the science classes given in high school includes chemistry. Medical, engineering, and pharmacy schools require students to pass this course as a pre-requisite for acceptance into their respective graduate programmes, all of which demand a strong background in science (Njoku, 2017). As an experimental science, chemistry is essentially reliant on the coherence of theory and application. As a result, it is important that it be taught as such in schools. As a result, students' understanding of chemistry will be improved if they can grasp the principles in practical chemistry (Ikeobi, 2019).

Despite the importance of Chemistry, pupils routinely perform badly in this subject on external exams like the West African Examinations Council (WAEC) (WAEC). Chemistry teachers may be to blame for this poor performance. When teaching and learning is centred on the teacher, the lecture method is viewed as an authority figure who imparts knowledge to students who have little or no involvement in the process (Agboghoroma, 2019). Even so, Adegoke (2012) has argued that only hardworking students may profit from the lecture style. As a result of the lecture technique, students are only passively participating in the

teaching-learning process and are not given the opportunity to address their specific requirements. Play simulation and analogy teaching strategies (P-STWA) can be used to teach chemistry in a different way.
For children and young adults, play is an active learning tool because it is an inherent feature of all life. It allows the learner to be free in the learning process without the burden of rules and regulations. Using simulations allows students to gain an understanding of complex systems in a risk-free environment. Analogical knowledge is transferred from the familiar to the unfamiliar analogical process through play-simulations or "Creative Drama" (Bracha, 2017). If so, it may explain why Onwukwe (2009) included it in his "Art in Science technique"—any planned use of an art form to communicate scientific information. As a teaching strategy, the Art-in-Science Technique aims to give science students a better understanding of how science and scientists work, to make science lessons more fun, and to inspire both teachers and students to be more creative. Therefore, the researcher intended to implement this combined P-STWA (Play-simulations and Teaching With Analogy) strategy by staging a theatrical production of the drama book "Courtroom of Crazy Elements" (Onwukwe,2009) "Teaching and Learning Science through Plays" is a series of books designed specifically for chemistry students. The teacher will be checking for digression because analogies will be drawn from a single source. It is hoped that the students' fear will be transformed into faith as they achieve their goals as a result of the play's inherent fun and relaxation, as well as the experience of ease in acquiring new and relevant knowledge. To avoid confusion and unplanned analogy use, the T-W-A model itself has built-in checks because the analogies will be written out before time is up.

Statement of Problem

For years, Chemistry students across the country have been underachieving. When reviewing students' WASSCE results from 2015-2018, the trend of poor performance in Chemistry was reaffirmed, according to the findings. The West African Examinations Council (WAEC) Chief Examiner's report in Chemistry from 2015-2018 reaffirmed the same trend of students' poor performance in Chemistry. According to the data, only about half of the students who took the WASSCE Chemistry exam earned a grade of C or higher (WAEC Chief Examiner reports, 2015-2018). A WAEC report on Chemistry students' performance from 2015 to 2018 found that, among other things, they were unable to answer questions about environmental concepts such as pollution and waste management; corrosion; and rusting/extraction of metals. It is possible that poor teaching methods, among other things, are to blame for the woeful chemistry test scores we are seeing.
Due to the diverse learning styles of Nigerian secondary school chemistry students, lecture-based instruction is not an option. Teachers are more concerned with meeting the requirements of the curriculum or completing the course of study for each term than they are with ensuring that their students are learning effectively. It is possible that the persistent decline in student achievement in Chemistry is due to a lack of focus on the academic needs of students during the learning process. As a result, it is critical to test out new approaches to instruction, such as role playing and teaching through analogy (P-STWA). These approaches not only take into account the academic requirements of students, but they also ensure that students of both sexes progress at their own rate. As a result, the primary issue addressed by this research is whether or not students will benefit more from using P-STWA than traditional lecture methods, and this was fundamental in this study.

Literature Review

Some studies have been done on the impact of play simulation and analogy teaching methods on students' chemistry achievement.
Okoye (2015) investigated the impact of teaching methods (play-simulation and lecture) on senior secondary school students' academic achievement and attitude toward geography. When it comes to memory questions, problem-solving questions, and retention tests, students who were taught using the simulation method performed better than those who were taught using the lecture method. Using a simulation technique, Abe (2013) found that secondary school students' English language learning

performance improved. As a result, both in the immediate and delayed recall tests, the experimental group outperformed the control group significantly. Using simulation-games as a teaching tool may help students remember what they have learned.

It was found that analogies can improve students' performance in mathematics, and Harrison and Treagust (2013) performed a study to find out how. Analogies that students are familiar with can help them better comprehend scientific concepts, according to the findings of the study. Using analogies effectively in the classroom is dependent on two main factors: (1) the systematic application of analogies, and (2) the use of analogies in context.

A study conducted by Obeka (2017) examined the impact of Power simulation games on students' academic performance and enthusiasm for environmental education concepts in Geography. Obeka analysis found that teaching strategies had a significant impact on student achievement, with those in the power simulation achieving higher, followed by those in power simulation. Those who were taught through lectures performed the worst. Furthermore, Umo (2011) conducted a study on the impact of games simulation on students' Igbo grammar achievement and interest. The study's findings revealed, among other things, that students' achievement in Igbo grammar was unaffected by game strategy. However, the results showed that students' interest in Igbo grammar was significantly influenced by game strategy. But Akinsola and Animashun (2017) conducted a study in which the impact of a simulation-environment game's on secondary school students' achievement and attitude toward mathematics was studied. The use of a simulation–game environment led to improved achievement and positive attitudes toward mathematics, according to the results of the data analysis. In order to keep students engaged in the classroom, he recommended that teachers use simulation/games teaching methods.

Students who participated in the study were assessed for their emotional and cognitive abilities using a teacher-created video game and analogy. During the study, genetics was discussed, and $p < 0.05$ was used for the statistical analysis of the achievement data. Students in the experimental and control groups were significantly more engaged than those in the control group, according to the findings. Only those who were taught via lecture performed better than those who were taught via analogy in terms of their learning outcomes measured by the instrument used.

Objectives of the Study

Generally, Play-Simulations (P-S) and Teaching With Analogy (TWA) were two instructional approaches tested to see how they affected secondary school chemistry students' performance. In more detail, the research looked into:;

1. difference in the mean achievement scores in chemistry among students' taught with play simulation, analogy and lecture method
2. difference in the mean achievement scores between chemistry students taught with play simulation and those taught with analogy teaching method
3. difference in the mean achievement scores in chemistry between students taught with play simulation and lecture method
4. difference in the mean achievement scores in chemistry between students taught with analogy and lecture method

Methods of the Study

Pretest and posttest control groups were used in this study's design, which was not randomised. Subjects in this study were not randomly assigned in any way. Experiment and control groups were made up of the same intact classes. There were 153 secondary schools and 11,756 SS2 students in the Delta North Senatorial District in Delta State, which served as the study's sample, making up the study's total population of SS2 Chemistry students. The 2019/2020 session had 6,176 female students and 5,580 male students. Study participants were drawn from a pool of 258 seniors in Senior Secondary II chemistry

classes at nine public secondary schools, representing a total sample size of nine (9) schools. For all stages of selection, this study also uses simple random sampling techniques.

Data Used

This study used one major instrument and three different kinds of lesson plans (Instructional package). The research instrument was identified as the "CAT" system, and this was developed to measure students' achievement on the units covered during the treatment. In its final form, it was 60 items ofobjective tests with selection of options. The CAT system was drawn from some selected SS2 topics in Corrosion and Rusting /Extraction of metals. These topics are from the SS2 scheme of work in Chemistry that lasted for six weeks. There was proof that the CAT was dependable. Based on the Kuder-Richardson's formula - 21 (K-R 21). The CAT was given out to 50 SS 2 Chemistry students in Abraka Grammar School, Ethiope East municipality of Delta State, which was not used during the actual study. The data was obtained using Kuder-Richardson's formula - 21 (K-R 21). The calculated K-R 21 estimate obtained was 0.86. This value met a standard that specifies that any instrument with a validity coefficient of 0.70 and above is considered reliable. The treatment was conducted in three phases. The first phase involved the assignment of selected schools into experimental (play-simulation and analogy instruction) and control (lecture) groups, and the second phase involved the training of the study's experimental group with regular chemistry teachers, who served as research assistants, with the treatment itself taking place in the third phase.

Treatment lasted for a total of six weeks; before treatment began, the CAT was administered to both groups to see if they were comparable in their understanding of the chemistry concepts they were taught. Using the pre-test score, the researcher was able to divide students into experimental and control groups. Every student was given a copy of the play "Courtroom of Crazy Elements" after the rules and regulations were read out loud. Corrosion and rusting/Extraction of meals and water were personified in the book, which was published in 2009. Environmental pollution and solid waste served as inspiration for the actors' personalities and interactions in the play, which were based on chemistry-related characteristics. Acclaimed Nigerian actors performed and recorded the play on VCD and DVD software. In addition to reading the book, students watched the play on a 21-inch TV screen and discussed its relevance to chemistry. It took an hour to complete this workout. After that, all of the students' copies of the text were returned to mark the end of the first day's play simulations.

Lessons in the P-STWA group had the following structure:

1. Classroom walls were adorned with charts containing lists of analogies from the play that could be used to explain environmental chemistry concepts.
2. This included 20 minutes of set induction, where participants were required to watch any part of the play that was most relevant to the day's topic. As a follow-up to their first visit, teachers reminded students to reflect on what they had learned and how the play simulation had aided them in doing so.
3. The day's lesson plan was scrawled on the whiteboard. Except for the analogies, the lesson followed the same flow as the lecture method and covered the same material. Analogies are a useful tool for teaching, but they are not a substitute for teaching. There were a few instances in which analogies were used to help students understand a concept or respond to their questions. The T-W-A model was used consistently to plan and implement the analogies in the lessons (Glynn, 1994). What follows is a list of examples from which analogies were drawn for the T-W-A model in the classroom (see lesson plans for the PSTWA chemistry lessons). An hour and a half was allotted to the group for each lesson, which included both 40 minutes of content development and 20 minutes of set induction.

The lecture method was used to teach the selected chemistry concept to the control group. Lectures were given to students in the control group by regular chemistry teachers. Despite this, a lesson plan was provided to the chemistry teachers by the researcher in order to ensure that the content was consistent.

The experimental and control groups were both post-tested at the end of the treatment. Analysis of the scores from the pre- and post-tests was done

Data Analysis

For the purposes of answering the research questions posed, descriptive statistics were employed. Presented as mean ± standard were used in this case. Null hypotheses were tested using t-test statistical analysis and the Analysis of Covariance (ANCOVA) method.

Research Question One: What is the difference in the mean achievement scores between chemistry students taught with play simulation and those taught with analogy teaching method?

Table 1: Mean scores and Standard Deviation of Chemistry Students exposed to play simulation, Analogy and Lecture Teaching Methods.

Variable	N	Pre-Test		Post-Test		Mean Achievement Gain
		Mean	SD	Mean	SD	
Play Simulation	89	12.32	2.43	57.32	4.19	45.00
Analogy	71	11.10	2.01	43.21	3.55	32.11

Table 1 shows the mean and standard deviation of the Pre-test and Post Test scores of students in the two different instructional strategies. The play simulation teaching strategy shows that the mean score for the pre-test was 12.32, while the standard deviation was 2.43, the post-test mean score was 57.32 and a standard deviation of 4.19. With respect to analogy teaching strategy, the pre-test mean score was 11.10 and a standard deviation of 2.01, while the post-test score of 43.21 and standard deviation of 3.55 was obtained. The mean achievement difference for both teaching methods stands at 45.00 and 32.11 respectively.

Hypothesis One (HO_1): There is no significant difference in the mean achievement scores between chemistry students taught with play simulation and those taught with analogyteaching strategies.

Table 2: t-test comparison of mean achievement scores of Chemistry students taught using play simulation and analogy methods

Group	N	Mean	SD	df	t-cal	Sig (2-tailed)	Decision
Play							
Simulation	89	57.32	4.19	158	7.191		$HO_1$is rejected
Analogy	71	43.21	3.55				

Table 2 shows that there is a significant difference in the posttest mean achievement scores between students taught using play simulation and those taught using analogy method, t = 7.191, < 0.05). Thus, HO_2 is rejected. This means that there is a significant difference in the mean achievement scores between chemistry students taught using playsimulation and those taught using analogy method in favour of students taught using Play simulation.

Research Question Two: What is the difference in the mean achievement scores between chemistry students' taught with play simulation and those taught with lecture method?

Table 3: Mean scores and Standard Deviation of Chemistry Students exposed to play simulation and Lecture Teaching Methods.

Variable	N	Pre-Test		Post-Test		Mean Achievement Gain
		Mean	SD	Mean	SD	
Play Simulation	89	12.32	2.43	57.32	4.19	45.00
Lecture Method	98	13.01	5.20	56.87	4.41	43.86

Table 3 shows the mean and standard deviation of the Pre-test and Post Test of the two types of instructional strategies. The play simulation teaching showed that the mean score for the pre-test was 12.32, while the standard deviation was 2.43, the post-test mean score was 57.32 and a standard deviation of 4.19. Table 9, also, showed that students taught with lecture method had a pre-test mean score of 13.01 and a standard deviation of 5.20, while the post-test mean score was 56.87 and standard deviation of 4.41. The mean achievement gains for the two teaching methods showed that students exposed to play simulation teaching strategy had the higher achievement gain of 45.00 than the lecture method with a gain of 43.86.

Hypothesis Two ($H0_2$): There is no significant difference in the mean achievement scores in chemistry between students' taught with play simulation and those taught with lecture method.

Table 4: t-test comparison of posttest mean achievement scores of Chemistry students taught using Play Simulation and those taught with lecture method

Group	N	$\bar{x}$	SD	Df	t-cal.	Sig. (2-tailed)	Decision
Play Simulation (Experimental)	89	57.32	4.19	185	7.274	0.000	HO_2 is rejected
Lecture (Control)	98	56.87	4.41				

Table 4 shows that there is a significant difference in the posttest mean achievement scores between chemistry students taught using play simulation and those taught using lecture method, t = 7.274, P< 0.05. Thus, HO_2 is rejected. This means that there is a significant difference in the mean achievement scores between chemistry students taught using playsimulation and those taught using lecture method in favour of students taught using Play simulation.

Research Question Three: Whatis the difference in the mean achievement scores between chemistry students taught with analogy and those taught with lecture method?

Table 3: Mean score and Standard Deviation of Chemistry Students exposed to Analogy and Lecture Teaching Methods.

Variable	N	Pre-Test		Post-Test		Mean Achievement Gain
		Mean	SD	Mean	SD	
Analogy	71	11.10	2.01	43.21	3.55	2.11
Lecture Method	98	13.01	5.20	56.87	4.41	3.86

Table 5 shows the mean achievement scores and standard deviation of the Pre-test and Post Test of chemistry students taught with analogy strategy and lecture method. The students taught with analogy strategy had pre-test mean score of 11.10 and a standard deviation of 2.01, while the post-test mean score was 43.21 and standard deviation of 3.55. Chemistry students taught with lecture method had a pre-test mean score of 13.01 and a standard deviation of 5.20, while the post-test mean score was 56.87 and standard deviation of 4.41. The mean achievement gains for the two teaching methods showed that

students exposed to lecture method had the higher mean achievement gain of 3.86 and analogy having the lower mean achievement gain of 2.11.

Hypothesis Three (HO_3): There is no significant difference in the mean achievement scores in chemistry between students taught with analogy and those taught with lecture method.

Table 6: t-test comparison of post test mean achievement scores of Chemistry students taught using Analogy and those taught lecture method

Group	N	$\bar{x}$	SD	Df	t-cal.	Sig. (2-tailed)	Decision
Analogy (Experimental)	71	43.21	3.55	167	8.274	0.000	HO_3 is rejected
Lecture (Control)	98	56.87	4.41				

Table 6 shows that there is a significant difference in the posttest mean achievement scores ofchemistry students taught with analogy and those taught using lecture method, t cal 8.274, P< 0.05. Thus, HO_3 is rejected. This implies that there is a significant difference in the mean achievement scores between chemistry students taught using analogy and those taught using lecture method in favour of students taught using Lecture method.

Discussion of Findings

A significant difference in posttest mean achievement scores was found between students taught using play simulation and analogy method (tcal = 7.191, P(0.000)0.05)), according to the findings of tables 1 and 2. Thus, the hypothesis of HO1 is ruled out. This suggests that students who are taught using play simulations outperform those who are taught using analogy methods in terms of their average achievement scores. This study supports the findings of Abe (2013), who studied the impact of simulation techniques on secondary school students' English language learning. As a result, both in the immediate and delayed recall tests, the experimental group outperformed the control group significantly. Using simulation-games as a teaching tool may help students remember what they have learned.

Play simulation teaching strategy had a higher mean accomplishment gain of 45.00 than that of the lecture method, which had a gain of 43.86, according to the findings from table 3. Because of this, there is a difference in the average test scores of chemistry students who are taught through play simulation and lecture. It was found, as shown in table 4, that students who were instructed in chemistry via play simulation outperformed those who were instructed via lecture method, with the difference being particularly pronounced in favour of the former. Researchers Obeka (2017) found the same thing when they looked at the impact of Power simulation games in Geography classes on students' ability to learn and interest in certain environmental education concepts. It was found that teaching strategies had a significant impact on student achievement, with those in the power simulation achieving higher, followed by those in the power simulation. Those who were taught using the lecture method fared the worst. Umo (2011), a researcher who studied the impact of games on Igbo grammar students' achievement and interest, disagrees with the findings of Umo (2011). Students' performance in Igbo grammar was found to be unaffected by game strategy, according to the findings. Students' interest in Igbo grammar was significantly influenced by game strategy, according to study results. There are strong parallels between this study's findings and the research done by Akinsola and Animashun (2017), who studied the impact of simulation-game environments on secondary school students' achievement and attitude toward mathematics in the classroom. Study after study has shown that students' performance and attitudes toward mathematics have both improved when using a simulation–game environment. Students will be more engaged if their teachers use simulation/games-based teaching methods, according to the author.

For the two instructional strategies, the mean and standard deviation are shown in Table 5. Using an analogy-based instructional strategy for the pre-test, students scored on average 11.10, with a standard deviation of 2.01, and on average 13.21, with a standard deviation of 3.55. When students in the lecture method of teaching chemistry took the post-test, their mean scores were 16.87, with a standard deviation of 4.41, while their post-test scores were only 13.01 and 5.20, respectively. When students are exposed to analogy and lecture methods, there is a difference in the average test scores of chemistry students. Students who were taught chemistry through analogy outperformed those who were taught through lecture by a wide margin, as evidenced by the results of the hypothesis test in Table 6. According to Anneta, James and Shawn (2019), who studied the impact of a teacher-created video game and analogy on students' cognitive and emotional abilities, this finding is consistent with their findings. During the study, genetics was discussed. p 0.05 was used for the statistical analysis of the achievement data. Students in the experimental and control groups were significantly more engaged than those in the control group, according to the findings. Only those who were taught via lecture performed better than those who were taught via analogy in terms of their learning outcomes measured by the instrument used. In another development, the findings of this study differ from those of Harrison and Treagust (2013), who used an observational schedule and interviews to gather data on a science teacher's use of an analogy of a Domino to teach heat conduction. Analogies that students are familiar with can help them better comprehend scientific concepts, according to the findings of the study.

Conclusion

The following conclusions were reached as a result of this research: Lessons taught using the Play simulation method outperformed those taught using the analogy method and lectures. As a result, students' chemistry grades benefit from using play simulations. Students who are taught via the lecture method outperform those who are taught via analogy strategy. To put it another way, an analogy-based approach to chemistry education has no impact.

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