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Effect of Simulation and Project Work Strategies on Science Education Students' Achievement and Problem-Solving Skills

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Abstract

The study investigated the effect of simulation and project work strategies on science education students' achievement and problem-solving skills. This study used the quasi-experimental non-equivalent pretest and posttest control group design. The population was 29,904SSII science students in public secondary school in Delta State. The sample is 214 students in 6 schools. The instruments used for data collection was Science Education Achievement Test (SEAT) and Problem-Solving Skills Scale (PSSS).The schools were randomly assigned into the control and experimental groups. The students in the control group were taught with the lecture method of teaching while the students in the experimental groups were taught using simulation and project work strategies. Before the study began, a pre-test for both the experimental group and control groups were conducted to assess their prior knowledge and problem-solving skills .The posttest was carried out after the study session to the test the ability of students from both the experimental and the control groups. The data obtained were analysed using ANCOVA to compare the score of students in the experimental and control groups. The results showed a significant difference in the effects of simulation strategy, project work strategy and lecture method on students' achievement and problem-solving skills in science education. The study, thus, concludes that the use of simulation and project work strategies in science education was more beneficial than the lecture method in relation to students' achievement and problem-solving skills. The adoption of simulation and project work strategies as a medium of instruction at all levels in Nigerian educational system to improve achievement and problem-solving skills of learners was recommended.

Keywords: Simulation Strategy, Project Work Strategy, Achievement, Problem-Solving Skills.

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Introduction

Science education is an essential instrument for national development. The impact of science and technology on the society cannot be overemphasized modern invention and discoveries have cumulatively helped to improve man's progress in health happiness and productivity. Omiko (2017) asserted that the relevance of science to national goals, aspirations and economy, dictates to large, the huge commitment and support which nations make and give to science and technological development. According to Osuabor and Okoli (2013) that in this contemporary age of science and technology advancement the need to keep pace with the global friend of development demands that people should be scientifically literate and have knowledge of problem-solving skills.Iroriteraye-Adjekpovu (2022) noted that without scientific and problem-solving skills literacy among a sizable proportion of the society, progress in achieving modernization will be difficult. In other words, the purpose of education should include not only the acquisition of knowledge, but also the process of employing knowledge, development and improvement of higher-order thinking strategies for problem solving skills and creativity.

Problem solving skill is very crucial in academic achievement of science students. As school student navigate the challenges of academics, relationships and personal growth, problem-solving skills becomes increasingly important. These skills not only help students overcome obstacles and find solution to complex problems, but also equip them with the ability to think critically, make informed decisions and effectively communicate their ideas. Edward, Burger and Michael (2018) emphasize the importance of developing effective problem-solving skills for success in various area of live.

Problem-solving skills refer to the ability to identify, analyze, and solve problems effectively (Iroriteraye-Adjekpovu, 2013). These skills involve various processes such as understanding the root cause of a problem, brainstorming potential solutions, evaluating the implications of different options and making a decision on the best course of action. Problem-solving skills also encompass the ability to adapt and think critically in complex or unexpected situations. They are essential for success in both personal and professional endeavors. Problem solving skill include, critical thinking, decision making, problem identification, creativity, analytical skills, flexibility, communication, collaboration, adaptability, time management, strategic planning, planning etc.

In schools these skills are crucial as students face a variety of academic and social challenges that require creative thinking and problem-solving abilities. Creating a supportive classroom environment is essential for fostering skills. Ajaji, Magbagbeola, and Owadayo (2021) emphasized the importance of integrating critical thinking into the curriculum to enhance problem-solving skills among students. Adenle and Adeyanju (2022) advocated for multi-disciplinary approaches in the classroom to improve students problem-solving skills. Based on the current literature the following problem-solving skills can enhance students' academic achievement.

1. **Critical thinking:** critical thinking is the ability to analyze and evaluate information to make sound decisions. It involves reasoning, logical thinking, and the ability to consider multiple perspectives. According to Hepper, (2020), critical thinking is crucial in problem solving as it helps individuals make well-informed decisions

2. **Decision making:** decision making involves choosing the best course of action from multiple alternatives. Authors moon and Blackman (2021) emphasize the importance of effective decision making in problem solving as it enables individuals to weigh the pros and cons of different options and select the most suitable solution.
3. **Creativity:** creativity involves thinking outside the box and generating innovative ideas to solve problems. According to Amabile and Pratt (2023) creativity is a valuable problem-solving skill that allows individuals and approaches to challenges
4. **Analytical skills:** analytical skills involve breaking down complex issues into smaller components and examining them in details Gupta and Agganrwal (2022) highlight the significance of analytical skills in problem solving to understand the root causes of problems and identify effective solutions.
5. **Flexibility:** flexibility is the ability to adapt to changing circumstances and be open to new ideas and approaches. According Tschannen-Moran and Hoy (2020) flexibility is a crucial problem-solving skill, as it allows individuals to adjust their strategies and solutions based on evolving situations
6. **Communication:** effective communication is essential for problem-solving skills, as it enable individuals to convey their ideas, listen to others and collaborate with team members. Authors Anderson et al (2023) emphases the role of communication skills in problem solving as they facilitate the exchange of information and the development of viable solutions.
7. **Collaboration:** working with others to find solution and achieve common goals
8. **Resilience:** being able to bounce back from setbacks and adapt to changes to overcome challenges
9. **Problem Identification:** recognizing and defining issues or challenges that need to be addressed.

Developing and improving problem solving skill in school offers numerous benefits. Firstly, it enhances students' academic performance by enabling them to approach complex tasks with confidences and efficiency secondly, it equips them with essential life skills that are applicable beyond the classroom, such as decision making, critical thinking and adaptability, also problem-solving skills foster resilience and perseverance, empowering students to overcome setbacks and achieve goals (Iroriteraye-Adjekpovu, 2012)

These problem-solving skills can be improved by using simulation and project work strategies. Simulation and project work strategies have been widely recognized as effective methods in enhancing students' achievement and problem-solving skills, particularly in the field of science education. Numerous scholars have explored the impact of these strategies on students'' learning outcome and have highlighted the benefits they offer educational system. Vygostlay (2018) emphasized the importance of simulating environment in promoting cognitive development.

Simulation is the act of encouraging or inciting a response or a desired behaviour. In the context of learning, simulation-based learning refers to the use of various techniques and methods to engage and motive learners in order to encourage a deeper and more effective learning experience (Iroriteraye-Adjekpovu, 2022; Egbule, 2020). Simulation based learning often involves activities that are designed to be interactive hand on and immersive in order to

capture the learners' attention and promote active participation. These activities can include role-playing, simulations, experiments, problem-solving exercises and other forms of experiential learning. Umoke and Nwafor (2014) emphasized that simulation instructional approach fostered higher achievement in science learning simulation-based learning also known as experiential learning, is a teaching and learning approach that encourages students to learn through active engagement and real-world experience. This approach emphasizes the importance of hand-on activities problem-solving critical thinking and reflection. Adenle and Adeyanju (2022) advocated for multidisciplinary approaches in the classroom to improve student's problem-solving skills. Simulation-based learning aims to create an environment where learning is not just about acquiring information, but also about applying that information in real-world context, fostering a deeper understanding and mastering of the material simulation involves engaging students in hand-on, interactive activities that simulate real-world situation. This can include experiment simulation and an interactive computer programme. Simulation is the process of imitating real-life system or process using a model in a controlled environment. Simulation enables learners and practioners to gain practical experience and develop problem-solving skills in a controlled setting. By providing students with opportunities to apply their knowledge in practical settings, Simulation helps to reinforce concepts and improve understanding. Jones and Moreland (2017), simulation-based learning has been found to improve student's comprehension of complex scientific concepts and enhance their problem-solving skills.

Project work strategies involve students working on a short or long-term in-depth projects that allow them to explore topics in greater details. In the view of Lawrence and Egbule(2021), this approach promotes critical thinking and problem-solving skills by requiring students to synthesize information, develop hypothesis and make connection between multiple concepts. Project based learning is an instructional approach that allows students to investigate real-world problems and create solution through hand-on project. Krajick and Blumentied (2006) emphasize that project-based learning promotes critical thinking collaboration, and communication skills which are essential for effective problem-solving in science education.

The use of simulation and project base learning in science education has gain significant attention due to its potential to engage students in active learning, improve their understanding of scientific concepts and enhance their problem-solving abilities. Olorunjede and Akinsola (2020) proposed integrating project-based learning approaches to develop students problem-solving activities. Ogunleye and Afolayan (2023) demonstrated the positive impact of collaborative learning on student's problem-solving abilities emphasizing the significance of cooperative interactions among students. This study aims to investigate the effect of simulation and project work strategies on science education student's achievement and problem-solving skills.

Statement of the Problem

The teaching and learning of science in secondary schools still remain problem to the science teachers due to abstract nature of some many concept in the science Hassan, Adio, Salawu and Christopher (2017) stated that the high rate of failure in science secondary

certificate examination has become a subject of constant comments by many people who discovered that the conventional or traditional principle of learning established b experimental psychologist are inadequate in solving the modern practical problems.

The trends in science and technology teaching over the last few years has been towards emphasizing problem solving skills and students centred learning problem solving skill is now recognized as central component of science proficiency (Carole & Roland, 2011) solving problem is an essential skill for the future workforce in many Science, Technology, Engineering and Mathematics (STEM) careers. In the context of science education,the development of problem-solving skills includes a variety of teaching strategies for theoretical concept to become more concrete (Wetwong, 2018). Although, problem solving skill is recognized as an important skills recent assessment indicates that students do not always perform well in this area. Several strategies were employed to improve students' performance in problem solving skills in school subjects. Among them also are the use of simulation-based learning and project work strategies for classroom instructions. Despite the potential benefits of simulation and project work strategies, there is a need to systematically examine their impact on students learning outcomes in the context of science education.

The extent to which the adoption of the approach could enhance student's achievement in science is still an issue that needs to be subjected to empirical investigation, this is the gap this study sought to address. Therefore, this study aimed to investigate the effect of simulation and project work strategies on science education students' achievement and problem-solving skills.

Purpose of the study

The main purpose of this study is to determine the effect of simulation and project work strategies on secondary school science education students' achievement and problem-solving skills.Specifically, the study was designed to:

1. Compare the effects of simulation, project work strategies and lecture method on students' achievement in science education.
2. Compare the effects of simulation, project work strategies and lecture method on students' problem-solving skills in science education.

Hypothesis

1. There is no significant difference in the effects of simulation, project work strategies and lecture method on students' achievement in science education.
2. There is no significant difference in the effects of simulation, project work strategies and lecture method on students' problem-solving skills in science education.

Methodology

This study used the quasi-experimental non-equivalent pretest and posttest control group design as shown in Tabl1.

Table 1: The design of the experimental study

Group	Pre-test	Treatment	Post-test
E1	O_1	X1	O_2
E2	O_3	X2	O_4
C	O_5	X3	O_6

Where, E1 and E2 = Experimental group 1 and 2, C = Control group, X1, X2, and X3 = Treatments using simulation strategy, project work strategy and lecture method, O_1, O_3, and O_5 = Pretest scores, and O_2, O_4, and O_6 = Posttest scores.

The population was 29,904SSII science studentsinpublic secondary school in Delta State. The sample is 214 students in 6 schools. The instruments used for data collection was Science Education Achievement Test (SEAT) and Problem-Solving Skills Scale (PSSS). The schools were randomly assigned into the control and experimental groups. The students in the control group were taught with the lecture method of teaching while the students in the experimental groups were taught using simulation and project work strategies.Before the study began, a pre-test for both the experimental group and control groups were conducted to assess their prior knowledge and problem-solvingskills.

The posttest was carried out after the study session to the testthe ability of students from both the experimental and the control groups. The data obtained were analysed using ANCOVA to compare the score of students in the experimental and control groups.

Result

HO_1: There is no significant difference in the effects of simulation, project work strategies and lecture method on students' achievement in science education.

Table 2: ANCOVA Summary on Effects of Simulation, Project Work and Lecture Method on Achievement

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	10235.459[a]	3	3411.820	40.792	.000
Intercept	64091.182	1	64091.182	766.280	.000
Pretest	4255.519	1	4255.519	50.879	.000
Methods	5917.041	2	2958.521	35.372	.000
Error	17564.279	210	83.639		
Total	701370.000	214			
Corrected Total	27799.738	213			

Table 2 shows a significant difference in the achievement scores among students taught science education using simulation, project work and lecture method, $F(2, 210) = 35.272$, $P(0.000) < 0.05$. Therefore, the null hypothesis is rejected. Thus, there is a significant difference in the effects of simulation, project work strategies and lecture method on students' achievement in science education. In order to determine the direction of the

difference among the three groups (simulation, project work and lecture), Scheffe's post-hoc test was performed as shown in Table 3.

Table 3: Scheffe's Post-hoc Test on Achievement Scores of Students Taught Using Simulation Strategy, Project Work and Lecture Method

(I) Teaching Strategies	(J) Teaching Strategies	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b] Lower Bound	Upper Bound
Simulation	Project	3.576*	1.569	.024	.483	6.669
	Lecture	12.477*	1.554	.000	9.414	15.540
Project	Simulation	-3.576*	1.569	.024	-6.669	-.483
	Lecture	8.901*	1.489	.000	5.966	11.837
Lecture	Simulation	-12.477*	1.554	.000	-15.540	-9.414
	Project	-8.901*	1.489	.000	-11.837	-5.966

The Scheffe's post-hoc test shows significant difference between the achievement scores of students taught using simulation strategy and those taught using project work strategy, favouring simulation strategy; significant difference between the achievement scores of students taught using simulation strategy and those taught using the lecture method, in favour of simulation strategy. The post-hoc test also indicates a significant difference between the achievement scores of students taught using project work strategy and those taught using lecture method, in favour of project work strategy. As indicated in table 3, among the three instructional strategies, simulation and project work proved more effective than the lecture method.

HO_2: There is no significant difference in the effects of simulation, project work strategies and lecture method on students' problem-solving skills in science education.

Table 4: ANCOVA Summary on Effects of Simulation, Project Work and Lecture Method on Problem-Solving Skills

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	10694.161[a]	3	3564.720	34.764	.000
Intercept	30481.015	1	30481.015	297.256	.000
Pretest	3172.128	1	3172.128	30.935	.000
Methods	6887.892	2	3443.946	33.586	.000
Error	21533.671	210	102.541		
Total	611508.000	214			
Corrected Total	32227.832	213			

Table 4 shows a significant difference in the problem-solving scores among students taught science education using simulation, project work and lecture method, $F(2, 210) = 33.586$, $P(0.000) < 0.05$. Therefore, the null hypothesis is rejected. Thus, there is a significant difference in the effects of simulation, project work strategies and lecture method on students' problem-solving skills in science education. In order to determine the direction of

the difference among the three groups (simulation, project work and lecture), Scheffe's post-hoc test was performed as shown in Table 5.

Table 5: Scheffe's Post-hoc Test onProblem-Solving Skills Scores of Students Taught Using Simulation Strategy, Project Work and Lecture Method

(I) Teaching Strategies	(J) Teaching Strategies	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b] Lower Bound	Upper Bound
Simulation	Project	-.375	1.737	.829	-3.800	3.049
	Lecture	11.637*	1.721	.000	8.245	15.030
Project	Simulation	.375	1.737	.829	-3.049	3.800
	Lecture	12.013*	1.653	.000	8.754	15.271
Lecture	Simulation	-11.637*	1.721	.000	-15.030	-8.245
	Project	-12.013*	1.653	.000	-15.271	-8.754

The Scheffe's post-hoc test shows no significant difference between the problem-solving skill scores of students taught using simulation strategy and those taught using project work strategy; significant difference between the problem-solving skill scores of students taught using simulation strategy and those taught using the lecture method, in favour of simulation strategy. The post-hoc test also indicates a significant difference between the problem-solving skill scores of students taught using project work strategy and those taught using lecture method, in favour of project work strategy. As indicated in table 5, among the three instructional strategies, simulation and project work proved more effective than the lecture method.

Discussion of the finding

The study revealed a substantial difference in the effects of simulation strategy, project work strategy and lecture method on students' achievement in science education. The results revealed that the stimulation and project work strategies produced a higher mean achievement score than the lecture method. This finding is in line with previous study conducted by Liv et al (2021) who findings highlighted the effectiveness of simulationstrategy in enhancing achievement in science education than the lecture method. Similarly, Doppelt (2023) reported that project-based learning stimulated creativity and innovation, thereby enhancing students'achievement in science.

The study further revealed that there is a significant difference in the effect of simulation, project work and lecture method on students' problem-solving skills, favouring simulation and project work strategies. It showed that the students problem-solving skills had improve when the simulation and project work strategies was used in teaching the sciences. This study is in line with that of Bada and Olaleye (2019) who investigated the impact of stimulating learning environment on students problem-solving abilities in physics.Their study demonstrated that interactive and hands-on activities significantly improved students problem-solving skills, leading to enhanced achievement in science education. Also, in a related study, Luna and Aguirre (2022) confirmed that project-based learning strategies

positively influenced student problem-solving skills, consequently enhancing their overall academic performance in science education.

Conclusion

From the finding, the study concludes that the use of simulation and project work strategies in science education was more beneficial than the lecture method in relation to students' achievement and problem-solving skills. Simulation based learning provide students with interactive experience that enhance their understanding of scientific concepts in problem solving, while project work strategies encourage critical thinking and collaboration. The integration of these strategies into science education creates a conductive environment for developing students' problem- solving abilities and achieving academic success. Therefore, the use of stimulated and project work strategies can highly improve students' problem-solving skills in science.

Recommendation

Based on the finding of this study, the following recommendations were made

1. Simulationand project work strategies should be adopted as a medium of instruction at all levels in Nigerian educational system to improve achievement and problem-solving skills of learners
2. State and federal government should equip all schools with necessary facilities for the application of simulated and project-based learning. This should include laboratories, computers and accessories.
3. Government should encourage and sponsor in service training for science teachers on the application of stimulated and project work strategies and learning to improve their knowledge and skills on these strategies.

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