NIGERIA STUDENTS SKILL ACQUISITION IN CHEMISTRY PRACTICAL IN THE EYES OF BRAINSTORMING INSTRUCTIONAL STRATEGY

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Abstract— The study investigated the effect of brainstorming instructional strategy on Nigerian students' learning outcomes in chemistry practical. Gender and interest served as moderator variables. The study adopted a quasi-experimental design involving pre-test, post-test, and control groups. The target population were all senior secondary two students offering Chemistry in the Ifo local government area of Ogun State, Nigeria. The sample was 115 chemistry students drawn from two senior secondary schools. Chemistry Practical Achievement Test (r = 0.87), Science Process Skills Acquisition Check List (r = 0.91), and Students Interest Towards Chemistry Practical (r = 0.67) were instruments used for data collection. Data was analyzed using percentages, frequencies, means, analysis of covariance, and multiple classification analysis at a 0.05 level of significance. Instructional strategy only has a significant effect on students' skill acquisition in chemistry practical ($F(1, 114) = 557.611$, $P < 0.05$). It was concluded that brainstorming instructional strategy led to improved Nigerian students' skill acquisition in chemistry practical. It is recommended that the brainstorming instructional strategy be integrated with other instructional strategies by teachers for teaching chemistry practically in secondary schools.

I. INTRODUCTION

Science education is one of the basic tools for attaining scientific development. This fact is enshrined in the National Policy on Education (NPE) by the Federal Ministry of Education [1], which states that science education should, among other things, equip students to live effectively in the modern age of science and technology for the purpose of socio-economic and political development. Chemistry, a science subject involving the composition, behavior, structure, and properties of matter, plays a crucial role in providing foundational knowledge that supports this goal of NPE. Chemistry is the central science that rests on the foundation of mathematics and physics and in turn underlies the life sciences in biology and medicine. To understand the living system fully, one must first understand the chemical reactions and chemical influences that operate within them. It is a core subject in all science-related programs: agriculture, engineering, medicine, biochemistry, microbiology, pharmacy, etc. Chemistry is an exciting but challenging subject as an academic discipline. Its principles and ideas are to produce the chemicals from which all manner of materials and consumer products are manufactured [2].

Chemistry, by its' nature, is a practical-oriented subject, providing lots of opportunities for the development of skills. These are called 'soft skills,' 'generic skills,' 'transferable skills,' or 'employability skills' that will take graduates beyond Chemistry knowledge into the professional world [3] [3]. Chemistry is expected to provide the graduates with a wide range of valuable and useful skills and knowledge that will be highly valued by employers in all sectors. This can be achieved through the provision of experiences and resources that may help develop/incorporate these skills while maintaining the chemical content of the curriculum [3]. Chemistry was introduced into the curriculum of secondary school education in Nigeria to realize the goal of education. One of such objectives of education in Nigeria is to make the individual self-reliant upon graduation from secondary school. Hence, the secondary school curriculum provides for all science subjects to be taught weekly with practical or laboratory activities. Practical activities are integrated with theory to strengthen the concepts and principles taught [4].

[5] defined practical activities as essentially a kind of scientific practice that provides a situation and an educative environment in which chemistry students can learn science while [6] affirmed that practical helps students develop process skills, critical thinking, and competences required for dealing with observation, classification, measurement, counting numbers, recording, communication, prediction, hypothesis, inference, experimentation, data interpretation, research, and contingency planning. Put together, the goals of practical activities for scientific courses are motivation, development of process practical skills, understanding the scientific method, and gaining a deeper grasp of the subject's theoretical characteristics. In the practical class, students are required to experiment by reading and understanding the given instructions, applying the learnt skills, and making the appropriate assumptions [7]. Chemistry embraces both theory and practice, and for that reason, needs instructional laboratories designed so that they upkeep and enhance the inquiry and synthesis of both ideas and materials [8]. Practical work in chemistry constitutes a major portion of chemistry education, which should be properly instructed; otherwise, other linked science disciplines will be affected negatively. Thus, secondary schools require well-equipped and working laboratories [9].[8] state that laboratory practical work may be

utilized as a potent learning resource of science; it is constructed on the principle of learning by doing, and it constitutes a vital part of science education. The practical aspirations in chemistry education paved the way for brainstorming instructional strategy. Brainstorming instructional strategy can be viewed as a technique in which an individual or a group engages in critical thinking to generate wide-ranging ideas and creative solutions toward solving a problem, while conventional methods make use of teacher(s) chalk-and-talk system of teaching without applying rudiments of educational pedagogy for enriched delivery of instructions.

It has also been discovered that students are not introduced early enough to laboratory training in the psychomotor skills at the SSIII, which may be another cause of poor students` learning outcomes in chemistry practical. The WAEC chief examiners' reports also identified poor levels of communication skills, inadequate practical exposure, poor quantitative skills, an inability to relate concepts in Chemistry to everyday life, and a lack of understanding of some Chemistry concepts [10]. The trend in students' (male and female) achievement in chemistry has been poor for some years, and there is an urgent need to improve on poor performance in both internal and external chemistry examinations. Process skill acquisition in chemistry may be an application of knowledge, concepts, and abilities acquired in practical courses to solve everyday life problems. The study of chemistry in secondary school is to aid students in acquiring some fundamental skills, knowledge, and competency needed for environmental issue resolution. The gained skills, information, and competency stimulate students' critical thinking, which is necessary for coping with real-life problems and improving students' achievement [11]. Active engagement with science will likely make students more interested and have a more positive attitude towards science.

Interest could play a substantial role in students' decisions to study science and develop interest in a subject [12]. Interest is a powerful motivational process that energizes learning, guides academic and career trajectories, and is essential to academic success. Interest is both a psychological state of attention and affect toward a particular object or topic and an enduring predisposition to reengage over time [13]. Interest is a key factor in the field of science education. Interest specifies the quality of personal significance. The content taught without relevance to everyday life led to the lack of interest. The experiments might be a significant tool for the development of more stable interests, which later influence the choices of courses, higher studies, and careers. Interest could also be seen as a feeling one has in the cause of wanting to know or learn more about something or somebody. Interest differs from one's personal attitude, which refers to the manner of behaving towards somebody or something [14]. In view of the above, this study investigated

- Effect of brainstorming instructional strategy on students' process skill acquisition in chemistry practical activities.
- Examine the moderating effect of gender on students' process skill acquisition when exposed to chemistry practical activities using the brainstorming instructional strategy.
- Determine the moderating effect of interest on students' process skill acquisition when exposed to chemistry practical activities using a brainstorming instructional strategy.

II. Research Methodology

The study used a pre-test, post-test, and control group quasi-experimental research design. The study used a 2 x 2 x 2 factorial matrix (two levels of treatment—brainstorming instructional strategy and conventional method of teaching; two levels of gender—male and female; and two levels of interest—high and low) where treatment and moderating variables were crossed. The dependent variable was students' learning outcomes in chemistry practical (achievement and process skill acquisition). The target population for the study was senior secondary two (SS2) students offering Chemistry in Ifo Educational Zones in Ifo Local Government of Ogun State, Nigeria.

The sample for this study was 115 students drawn from senior secondary schools offering Chemistry in the Ifo Educational Zone of Ogun State, Nigeria. Two senior secondary schools were purposively (purposive sampling technique) selected for the study based on the following criteria.

- They were coeducational.
- They have chemistry laboratories with functional facilities and apparatus.
- The schools were not located close to each other to prevent the interaction effect of the participating students.
- The respective school management should be willing to approve the conduct of the experiment in their schools.

In each of the schools selected, one arm of each of the SS 2 students participated in the study. Randomization was used for assigning schools into experimental and control groups. The various validated instruments used for this study are the Brainstorming Instructional Guide (BIG), the Science Process Skills Acquisition Checklist (SPSAC), and the Students Interest towards Chemistry Practical Questionnaire (SICPQ).

III. Method for Data Analysis

Data collected was subjected to descriptive and inferential statistics. While the descriptive statistics was involving the use of means and standard deviations, the inferential statistics involved the use of Analysis of Covariance (ANCOVA) with pretest scores as covariates. The hypotheses generated were tested at 0.05 level of significance.

1. What are the mean process skill acquisition scores of students taught chemistry practical using the brainstorming instructional strategy and those taught using the conventional method?

Table 1. Mean Process Skill Acquisition Scores of Students in Chemistry Practical (Brainstorming and Control Group)

	Conventional Method Mean Score	**Brainstorming** Mean score	**Mean Difference**
Mean	32.97	71.45	38.48
SD	4.54	5.60	
N	69	46	

Table 1 showed the analysis of students' post-test mean skills acquisition score in Chemistry practical in the two groups, the control group and the Brainstorming group. The result shows that students in the control group obtained post-test mean score of 32.97, SD = 4.54 (N=69) while students in the Brainstorming instructional strategy group obtained post-test mean score of 71.45, SD = 5.60 (N=46).

H_o1: There is no significant main effect of instructional strategy on Students' skill acquisition in Chemistry practical

Table 2. Summary of Analysis of Covariance of Students skill acquisition in Chemistry practical According to Treatment, Gender and Interest

Tests of Between-Subjects Effects					
Source	**Type III Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig.**
Corrected Model	41551.057[a]	8	5193.882	256.595	.000
Intercept	1773.460	1	1773.460	87.615	.000
Covariates	445.834	1	445.834	22.026	.000
Gender	22.127	1	22.127	1.093	.298
Interest	3.012	1	3.012	.149	.700
Treatment	11286.904	1	11286.904	557.611	.000
Gender * Interest	93.009	1	93.009	4.595	.034
Gender * Treatment	8.044	1	8.044	.397	.530
interest * Treatment	6.927	1	6.927	.342	.560
Gender * interest * Treatment	22.059	1	22.059	1.090	.299
Error	2145.603	106	20.242		
Total	312704.000	115			
Corrected Total	43696.661	114			
a. R Squared = .951 (Adjusted R Squared = .947)					

Table 2 showed the result of the test on the main effect of treatment on students' skill acquisition in Chemistry practical. The result showed a significant main effect of treatment ($F(1, 114) = 557.611$, $P < 0.05$). This indicated that students in the brainstorming instructional strategy group and the control group differ significantly in the post-test mean skill acquisition score obtained in chemistry practical after the treatment. Hence, there is a significant effect of instructional strategy on students' skill acquisition in chemistry practicals in the Ifo local government area of Ogun State, Nigeria.

Table 3 shows further analysis of the students' skill acquisition score in chemistry practical across groups in terms of magnitude; this was done through multiple classification analysis (MCA).

Table 3. MCA of Students Post Test Mean Score in skill acquisition in Chemistry Practical according to Treatment (Grand Mean = 48.36)

			Deviation			
		N	***Unadjusted***	***Eta***	***Adjusted for Factors***	***Beta Adjusted for Factors***
Treatment	*Control*	69	-15.39420		-15.43842	
	Brainstorming	46	23.09130	.967	23.15763	.970

Table 3 shows the levels of students' post-test mean skill acquisition score in Chemistry practical in the two levels of treatment. The MCA shows a grand mean of 48.36, the students in the control group (conventional method) recorded adjusted post-test mean skill acquisition score of 32.92 (-15.44+ 48.36), while students taught with Brainstorming instructional strategy recorded adjusted post-test mean skill score of 71.517 (23.15+48.36). This outcome thus shows that students taught with Brainstorming instructional strategy recorded higher adjusted post-test mean skill acquisition score in Chemistry practical.

H_o2: There is no significant main effect of interest on students' skill acquisition in Chemistry practical

The result of the analysis of covariance in Table 2 shows no significant main effect of interest on Students' skill acquisition in Chemistry practical ($F(1, 114) = .149$, $P > 0.05$). This result implies that the post-test mean skill acquisition score of students with high and low interest in Chemistry practical in the treatment and control group is not statistically different. Hence, the null hypothesis H_o2 is retained.

Table 4. MCA of Students Post Test Mean Score in skill acquisition in Chemistry Practical According to Interest (Grand Mean = 48.36)

			Deviation			
		N	**Unadjusted**	**Eta**	**Adjusted for Factors**	**Beta Adjusted for Factors**
Interest	Low	56	-1.31165		-.40650	
	High	59	1.24495	.066	.38583	.020
						R=.968
						R Square

The result of MCA on gender in Table 4 shows a grand mean of 48.36, students with low interest recorded adjusted post-test mean skill acquisition score of 47.95 (48.36 - 0.41) and students with high interest recorded adjusted post-test mean skill acquisition score of 48.74 (48.36+.3858). This outcome indicates that students with high interest recorded higher post-test mean skill acquisition scores in chemistry practical. However, the difference is not significant. In addition, interest in the study as a moderating variable contributed 2.0% to the variance in students' skill acquisition in Chemistry practical.

IV. Discussion of Finding

The result shows that treatment had a significant effect on Nigerian students' skill acquisition in practical chemistry. The study of chemistry in secondary school seeks to aid students' acquisition of some fundamental skills, knowledge, and competency needed for environmental issue resolution. The study revealed that students taught with the Brainstorming instructional strategy had a higher adjusted post-test mean skill acquisition score in Chemistry practical with an achievement score of 71.517 compared to the control group with a lower value of 48.36. The researcher observed students as they interacted in their groups, and most of the students displayed good communication skills and improved teamwork, which is also in agreement with the study of [15] that also recorded the development of skills by the respondents in the study. This is indicative of the fact that brainstorming allows for skill development when students are exposed to the strategy. Some of the skills the researcher observed among the students during the chemistry practical brainstorming session include communication skills, teamwork, critical thinking, measuring skills, proper dilution skills, and correct observation recording skills. Most of the students were not time conscious due to the longer time they utilized for brainstorming. This might be because they are still new to the technique. Also, according to the study of [16], the findings showed that there are statistically significant differences at the level of ($\alpha = 0.05$) between the experimental group and the control group in the total score and the sub-scores of the creative thinking in the favor of the experimental group, indicating the effectiveness of using the brainstorming strategy in developing creative thinking skills, which is in line with the result of this study. The finding aligns with the submission that the application of various methods and techniques in the lessons has been shown to help the development of scientific process skills [17, 18, 19, 20]. The finding of this study is in line with the findings of [21, 22], which also discovered that there is a significant difference between the experimental group and the control group in favor of the brainstorming strategy, therefore confirming that it is statistically significant.

V. Effect of Interest on Skill Acquisition in Chemistry Practical

The findings of this study showed a non-significant interaction effect of treatment and interest on students' skill acquisition in Chemistry Practical. According to the result of [23], analysis of the data showed that the majority of the students had positive attitudes towards the technical skills involved in technical education. There are positive relationships between students' attitudes in technical skill acquisition and their performance, which do not agree with this study's result. [24] found that students with science-related future career interests in science acquired science process skills in basic science. The use of brainstorming as an instructional strategy should be made more popular and adopted by teachers for teaching chemistry practically in secondary schools due to its efficacy in improving students' achievement and skills acquisition in the practical aspect of chemistry. To have improved students'

engagement in laboratory activities, leading to skill acquisition, brainstorming instructional strategy should be suggested to chemistry curriculum planners as an important strategy for integration with other problem-solving instructional strategies by teachers in Nigerian secondary schools. Students' interest in chemistry practical should be sustained while teachers should not discriminate between students with high and low interest, as it was found that they both achieved in similar directions.

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