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## EFFECT OF ELABORATIVE-GENERATIVE INSTRUCTIONAL STRATEGY ON CHEMISTRY STUDENTS' DEMONSTRATION OF SCIENCE PROCESS SKILLS IN AKWA IBOM STATE

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### **Abstract**

*A teaching method adopted by a Chemistry teacher could make or mar the level of demonstration of skills which would translates into deep understanding of the concept taught. This has resulted in Chemistry scholars advocating adoption of student- centered instructional strategies that would ensure active participation of students in the teaching-learning process. This study determined the effect of Elaborative-generative (EgIS)) instructional strategy on secondary school students' demonstration of science process skills in Chemistry in Uyo Educational Zone of Akwa Ibom State, Nigeria. Pretest–posttest control group, quasi experimental design was used. Two out of 12 co-educational public secondary schools with well-equipped laboratories were purposively selected for the study. Intact class of Senior Secondary II Chemistry students constituted the study population. Two research questions and two null hypotheses guided the study. One researchers' developed instrument tagged 'Science Process Skills Demonstration Rating Scale' (SPSDRS) with a reliability coefficient ( $r=0.81$ ) was used for data collection. Data collected were analyzed using mean and Analysis of Covariance (ANCOVA). There was a significant main effect of treatment on students' demonstration of science process skills. Students exposed to elaborative generative instructional strategy (EgIS) had a higher level of demonstration of science process skills with grand mean of ( $X = 38.39$ ) than those in control ( $X = 28.52$ ) group. Gender was not a significant determinant of students' demonstration of science process. It is therefore recommended that Chemistry teachers should apply elaborative-generative instructional strategy in teaching to promote students' science process skills demonstration in Chemistry irrespective of gender.*

**Keywords:** Elaborative-generative Strategy, Science Process Skills, Chemistry, Electrolysis.



## 1. Introduction

### 1.1 Background Views

Chemistry is one of the science subjects that would promote scientific, technological and economic development of any nation. The fundamental principles of teaching Chemistry is to enable students to investigate, explain and predict new phenomena in Chemistry. This could be achieved through the use of appropriate enquiry based instructional strategy to equip students with Chemistry knowledge, skills and competencies as tools for solving societal problems. As posited by Owoyemi and Adesoji (2012), one of the principal goals of teaching science subjects especially at secondary school level is to equip students with knowledge, skills, attitude and creative thinking abilities as scientists for technological development. Similarly, Onwioduokit (2015) averred that any knowledge of science that cannot be applied towards development of the society is not meaningful. Hence, the ability to reverse these challenges is not only tied to education but more on the critical mass of innovative instructional delivery particularly in Chemistry. Chemistry teachers of course ought to employ student-centered instructional strategy that would make their teaching participatory, exploratory, and experimental for students to demonstrate relevant practical skills that would facilitate deep understanding.

Obanaya (2020) stated that, success in the 21<sup>st</sup> century life lies more on students' personality transformation through the use of students– centered instructional strategy and minds –on activities while teaching to equip students with hard, soft and go-getting skills. Strengthening the views of scientific teaching Udofia (2015), emphasized that Chemistry could be learnt meaningfully when students develop flexible understanding of both knowledge content and process skills. This would involve manipulating scientific equipment, satisfying students' curiosity about the world and meeting individual students' relevant knowledge, skills and attitude based on applied instructional strategy.

Instructional strategy includes all approaches that a teacher may use to actively engage students in learning. Successful teaching and learning of Chemistry demands flexible pedagogy for effective self-monitoring and deep understanding of concepts (Udofia and Edem 2019). Currently, there seems to be poor students' engagement in laboratory activities especially in Chemistry instructional situations that would enhance their demonstration of science process skills for better understanding of facts.

Previous studies had identified various problems contributing to poor students' achievement in Chemistry. They include poor manipulation of science process skills (Duran and Ozdemir, 2010.); use of inappropriate instructional strategies (Udo and Udofia, 2014; Agbasi and Okeke 2020), abstract nature of Chemistry (Attah and

Njoku, 2018), among others. For learning to be effective and meaningful, Oyelekan, *et al.* (2017) stressed that Chemistry teachers must use appropriate teaching strategies to stimulate and encourage students' involvement in the learning processes. However, it is observed that the regular Chemistry class in public secondary schools is characterized by the teachers use of lecture method with students as passive listeners and note copiers. Teaching is controlled by the teacher. Students seldomly interact or explore in the lecture method class (Offorma *et al.*, 2019)

The Federal Republic of Nigeria (2013) in the National Policy on Education stated that the study of Chemistry as a science subject shall be participatory, exploratory, experimental and student-centered for students to acquire and demonstrate practical skills, develop positive attitudes, understanding and knowledge relating to occupations in various sectors of economic and social life. This would cater for students' diversity and accomplishing of the varied learning outcomes that are both behavioral and cognitive.

Elaborative-generative instructional strategy is an active and innovative student-centered strategy that engages students in an inquiry-based hands-on activities. Osioma (2012), remarked that active instructional strategy is an intentionally planned set of strategy which posed the responsibility of learning on the students. Ukoh (2013) and Udofia (2015) submitted that active instructional strategies have positive effects on students' achievement, improve problem solving skills, reduce students' anxiety, and enhance acquisition and demonstration of science process skills. This in essence will stimulate development of positive attitude towards the study of Chemistry.

Elaborative-generative instructional strategy is therefore an innovative strategy that enhances learning through conceptual change with the teacher providing an engaging learning environment for the students to be actively involved in constructing knowledge and process skills acquisition and demonstration. Nworgu and Otum (2013) asserted that process skills have an enduring quality that can contribute to students' abilities to answer questions and solve problems even when the information base of science and technology changes. According to Yadav and Mishra (2013) process skills are series of connected actions or experiences which go on internally (mind-set) within the students and can be demonstrated externally (hands-on) during scientific investigation. Science process skills therefore, play an important role in the demonstration of students' abilities to exercise the power of thought, taking decision, elaborate ideas and solve quantitative problems.

Student personal variables such as gender, learning style, attitude and interest have been linked to students' achievement and demonstration of science skills in

Chemistry by researchers. Ezedu and Obi (2013) reported female superiority in acquisition of science process skills while Oyelekan *et al* (2016) submitted that gender would not make a significant contribution to students' achievement in Chemistry. This study therefore, investigated the effect of elaborative-generative instructional strategy on students' demonstration of science process skills in chemistry based on gender.

## 1.2 Statement of the Problem

Poor Chemistry results is a recurring problem in Nigeria in public examinations like WAEC and NECO and is traceable to factors such as the dearth of manpower especially in Chemistry, inappropriate instructional strategy, poor demonstration of science process skills, abstract nature of Chemistry; and students' personality variables like gender and attitude.

Studies in Nigeria have highlighted different instructional strategies and their efficacies in enhancing students' cognitive performance in Chemistry with little or nothing done on science process skills demonstration using Elaborative- generative instructional strategy in teaching the concept of electrolysis in Chemistry. This persistent poor students' achievement in Chemistry leaves one in doubt about the efficacy of instructional strategy used by Chemistry teachers towards quantitative and qualitative learning. The problem of this study, therefore, was to determine the effect of Elaborative-generative instructional strategy on secondary school students' demonstration of science process skills in Chemistry based on gender.

## 1.3 Purpose of the study

This study determined the effect of Elaborative –generative and conventional instructional strategies on secondary students' demonstration of science process skills in Chemistry in Uyo Education Zone.

## 1.4 Research Questions

What difference exist between science process skills demonstration mean scores of students taught electrolysis using elaborative – generative instructional strategy and conventional instructional strategy?

What is the difference between science process skills demonstration mean scores of male and female students taught electrolysis using elaborative–generative instructional strategy and conventional instructional strategy?

## 1.5 Research Hypotheses

There is no significant difference in the science process skills demonstration scores of students taught electrolysis using Elaborative–generative instructional strategy and conventional instructional strategy?

There is no significant difference in the science process skills demonstration of male and female students taught electrolysis using elaborative – generative instructional strategy and conventional instructional strategy?

## **2. METHODOLOGY**

The pretest–posttest, control group quasi- experimental research design was used in the study.

### **2.1 Population and Sampling Technique**

The target population consisted of all Chemistry students in the 12 co-educational public secondary schools in Uyo Federal Constituency of Akwa Ibom State, Nigeria numbering 1294 students. A sample of 174 SS2 students from two public secondary schools were randomly selected and an intact class each was used from the selected schools. The selected schools were randomly assigned to treatment and control groups.

### **2.2 Instrument for data collection**

The researchers developed instrument tagged Science Process Skills Demonstration Rating Scale' (SPSDRS) was to collect data. SPSDRS consisted of two parts, part- A on personal variable while part B was on-the-spot assessment of students' demonstration of science process skills. Three experts rated the SPSDRS and the reliability of the instrument was calculated using Kuder Recharadson-20 (KR-20) and a coefficient of 0.81 was obtained

## **3. RESULTS**

The results for answering the two research questions are summarized in Tables I and 2 while the two hypotheses are summarized in Table 3.

### **Research question 1**

What difference exist between science process skills demonstration mean scores of students taught electrolysis using elaborative – generative instructional strategy and conventional instructional strategy?

**Table 1. Mean and standard deviation scores of students' demonstration of Science process skills by treatment (Elaborative – generative: EgIS, N= 103; Conventional instructional: N= 71)**

Process skills	EgIS (Expt) $\bar{X}$	CIS (Control) $\bar{X}$	Remarks
Observing	35.34	28.62	Expt High Mean
Measuring	37.54	23.25	Expt High Mean
Recording	33.42	27.99	Expt. High Mean
Inferring	37.98	26.32	Expt High Mean
Manipulating	38.68	15.09	Expt High Mean
Problem solving	30.33	34.76	Control High Mean
Reporting	36.08	23.09	Expt High Mean
Reasoning	22.76	17.27	Expt High Mean
Grand Mean	38.39	28.52	Expt High Mean

*Source: Researcher Computation.*

In Table 1, the mean scores of students shows that students exposed to EgIS had higher of level of demonstration of science process skills with grand mean ( $X = 38.39$ ) than CIS with a grand mean of ( $X = 28.52$ ). Students taught with EgIS were better in skills of observing, measuring, recording, inferring, manipulating, reporting and reasoning while students exposed to CIS did better in problem solving. The high mean gain score for students in experimental group indicates that the strategy facilitated active participation resulting in higher level of demonstration of science process skills in Chemistry.

### **Research question 2**

What is the difference between science process skills demonstration mean scores of male and female students taught electrolysis using elaborative–generative instructional strategy and conventional instructional strategy?



**Table 2: Mean ( $\bar{X}$ ) and standard deviation of the pretest and posttest scores of students' demonstration of Science Process Skills by Treatment and Gender.**

Treatment Groups	Gender	N	Pre-test		Post test		Mean Gain
			$\bar{X}$	SD	$\bar{X}$	SD	
EgIS	Male	38	10.92	8.23	39.52	8.93	28.60
	Female	65	9.63	6.74	38.05	6.54	28.42
Total		103	10.28	7.49	38.79	7.73	28.51
CIS	Male	30	11.06	6.88	33.64	7.51	21.58
	Female	41	9.20	4.36	28.89	6.05	18.69
Total		71	10.14	5.66	28.27	6.78	20.14

Source: Researcher Computation.

The result presented in Table 2 shows that male and female students had mean gain of (28.60) and (28.42) respectively in the experimental group while the mean gain scores of 21.58 and 18.69 was recorded by male and female students in the control group. The mean gain scores for male and female students in experimental are very close and higher than those in the control group. The male students in EgIS did better in demonstration of science process skills than the male in CIS. Also, the female students in experimental group did better in demonstration of science process skills than female students in the control group.

**H<sub>01</sub>** There is no significant main effect of treatment on students' demonstration of science process skills in chemistry.



**Table 3: Analysis of Covariance (ANCOVA) of posttest scores of students' demonstration of Science process skills classified by treatment and gender using pre-test scores as covariates.**

Sources of variation	Type III sum of square	df	Mean square	F	Sig
Corrected model	42470.961	2	21235.4805	55.398	0.000
Intercept	50836.443	1	50836.443	468.992	0.000
Pretest scores	465.938	1	465.938	6.373	0.002
Treatment	9370.640	1	9370.640	99.704	0.000*
Gender	91.385	1	91.385	0.001	0.176
Treatment x Gender	4.744	2	2.372	0.050	0.649
Error	12077.057	172	46.992		
Total	322658.000	178			
Corrected total	55766.182	177			

*R squared = 762 (Adjusted R squared = 756) \* = significant at  $P < 0.05$  alpha level*

*Source: Researcher Computation*

The finding in Table 3 has shown that there was a significant main effect of treatment on students' demonstration of science process skills in Chemistry. ( $F_{1, 172} = 99.704$ ;  $P < 0.05$ ). This implies that the posttest scores of students' demonstration of sciences process skills differs significantly between experimental and control groups. Hence the null hypothesis ( $H_{01}$ ) was rejected. The finding also showed that there was no significant main effect of instructional strategy on male and female students demonstration of science process skills taught using Elaborative – generative and conventional instructional strategies at ( $F_{1, 172} = 0.001$ ;  $P > 0.05$ ). Therefore, the null hypothesis ( $H_{02}$ ) was retained.

#### 4 Discussion

##### Research Question 1 and Hypothesis 1

From Table 1, the mean scores showed that students taught with EgIS were better in demonstration of skills of observing, measuring, recording, inferring, manipulating, reporting and reasoning while students exposed to CIS did better in problem solving. The result in Table 3 showed that there was a significant main effect of treatment on students' demonstration of science process skills in Chemistry. Students exposed to Elaborative-generative instructional strategy (EgIS) performed much better than those in the conventional instruction strategy (CIS) in demonstration of the science process skills. The result was consistent with previous finding by Oloyede (2012) who found that activity-oriented instructional strategies enhanced the demonstration of science process skills in Chemistry. The positive effect of EgIS over CIS on students' demonstration of science process skills is not surprising as EgIS was

a student- centered strategy with more authentic hands-on, minds- on practical activities. The finding was in conformity with the reports by Onwioduokit (2002); Musasia, Abacha and Biyoyo (2012) and Ukoh, (2012) who in their different studies reported that science process skills are gained when students actively participate in scientific activities.

### **Research question 2 and Hypothesis 2**

Table 2 showed that there was a difference in the mean scores of male and female students in demonstration of science process skills taught using EgIS and CIS in favour of the male students. From Table 3, although the mean score showed that male students were better in demonstration of science process skills than female counterparts, it was not significant. The non- significant main effect of gender on students' demonstration of science process skills could be probably due to the fact that both male and female students were given equal opportunities and support to participate in hands-on practical activities. The finding agreed with Udofia (2015) and Oyelekan *et al* (2016) who submitted that gender would not make a significant contribution to students' achievement in Chemistry. The findings is in consonance with previous reports by Nwagbo and Chukelu (2011) and Ogunleye and Babajide (2011) who reported a non-gender superiority on students' demonstration of science process skills in Biology and Physics.

However, the finding is at variance with report made by Adesoji and Ibrahim (2009) who found significant main effect of gender on students' demonstration of science process skills in Chemistry with the female performing better than male students. The study concludes that gender is not a determining factor in students' demonstration of science process skills.

## **5 CONCLUSION AND RECOMMENDATIONS**

### **5.1 Conclusion**

This result of the study indicates that Elaborative-generative instructional strategy is superior to conventional instructional strategy in enhancing students' demonstration of science process skills in chemistry. Therefore, EgIS could be used to facilitate mental and physical engagements in any teaching process in Chemistry irrespective of students' gender.

### **5.2 Recommendations**

Based on the findings of the study, the following recommendations are made:

- Elaborative-generative instructional strategy should be adopted by Chemistry teachers to facilitate students' demonstration of science process skills
- The teachers training programme facilitators in Nigerian Universities and Colleges of Education should include in their curriculum, the training of

- teachers on innovative and participatory instructional strategies.
- Furthermore, the government of Akwa Ibom State, Nigeria should equip secondary school laboratories with modern science equipment, reagents and chemicals for effective inquiry-oriented teaching of Chemistry concepts

## References

- Adesoji, F. A., and Ibraheem, T. L. (2009). Effects of student teams-achievement divisions strategy and mathematics knowledge on learning outcomes in chemical kinetic. *The Journal of International Social Research*, 2(6), 15-25.
- Agbasi, O.S., and Okeke, S.O. C (2020) Effects of reflective instructional strategy on secondary school students achievement in Awaka Educational Zone, Anambra State. *UNZIK Journal of STM Education*, 3(2), 201-210.
- Attah, F. O., and Njoku, Z. C. (2018). Effects of two teaching methods on secondary school students achievement in writing and balancing chemical equation. In: Z.C.Njoku, U.M. Nzewi and C.V. Nnaka ( Editors). *Perspectives on Science and Technology Education in Nigeria*. Great AP Express Publishers, Nsukka, Nigeria. 302p
- Duran, A., and Ozdemir, O. (2010). The effects of scientific process skills based science. *US-China Education Review*, 7(3), 1548-6613.
- Ezedu, F. O., and Obi, T. N. (2013). Effects of gender and location on students achievement in secondary schools in Nsukka Local Government Area of Enugu State, Nigeria. *IISTE-Research on Humanities and Social Sciences*, 3(15), 50-55.
- Federal Government of Nigeria (2013). National Policy on Education 6<sup>th</sup> Edition. Nigerian Educational Research and Development Council (NERDC) Press, Lagos.
- Musasia, A. M., Abacha, O. A., and Bayoyo, M. E. (2012). Effect of practical work in physics on girls' performance, attitude change and skills acquisition in the form two-form three secondary schools' transition in Kenya. *International Journal of Humanities and Social Science*, 2(23), 151-166.
- Njoku, Z. C. (2002). Enhancing girls' acquisition of science process skills in co-educational schools. An experience with sex grouping for practical chemistry. *Journal of Science Teachers Association of Nigeria*, 37(1&2), 125-135.



- Nwagbo, C., and Chukelu, U. C. (2011). Effects of biology practical activities on students process skills acquisition. *Journal of the Science Teachers Association of Nigeria*, 46(1), 58-70.
- Nworgu, L. N., and Otum, V. V. (2013). Effects of guided inquiry with analogy instructional strategy on students' acquisition of science process skills in biology. *Journal of Education and Practice*, 4(27), 35-40.
- Obanya, P. (2020). Re-engineering education in Nigeria to meet 21<sup>st</sup> century realities. *Nigerian Universities Journal of Education (NUJE)*, 1(1), 1-18.
- Ogunleye, B. O., and Babajide, V. F. T. (2011). Generative instructional strategy enhances senior secondary school students' achievement in physics. *European Journal of Educational Studies* 3. 3: 453-463.
- Offorma, G. C., Ikonta, N. R., and Ogunleye, A. O. (2019). Reforms in science, mathematics and technology STM curriculum. *Essentials of curriculum studies*. Nigerian Academy of Education. 243-280
- Oloyede, O. I. (2012). The relationship between acquisition of science process skills, formal reasoning ability and chemistry achievement. *IJAAAS* 8(1), 1-4.
- Onwioduokit, F. A. (2002). An on-the-spot assessment of science process skills in integrated science. *Journal of Education*, 2(1), 1-11.
- Onwioduokit, F. A. (2015). Recent innovations in science from primary to tertiary education level in Nigeria. *Journal of Research and Development in Education* 5(2) 12-28
- Osisioma, I. (2012). Moving from theory to practice: Applying research on students learning to science education. *Education in Nigeria from beginning to the future*. U.M.O. Ivowi and B. Akpan. Eds. Educational Services Ltd, Lagos. 269-302.
- Oyelekan, O. S., Igbokwe, E. F., and Olorundare, A. S. (2017). Science teachers utilization of innovative strategies for teaching senior science in Ilorin, Nigeria. *Malaysian Online Journal of Educational Science*, 5(2), 49-65.
- Owoyemi, T. E., and Adesoji, F. A. (2012). Isolation of teaching effectiveness factors from Nigerian senior secondary school chemistry student' point of view. *British Journal of Art and Social Sciences*, 9(11), 168-182.

- Udo, M. E., and Udofia, T. M. (2014). Effect of mastery learning strategy on students' achievement in symbols, formulae and equations in chemistry. *Journal of Educational Research and Reviews*, 2(3), 28-35.
- Udofia, T. M. (2015). Effects of elaborative-generative and exploratory-discovery instructional strategies on secondary school students' learning outcomes in chemistry in Akwa Ibom state, Nigeria, Ph.D. *Thesis of Department of Teacher Education. University of Ibadan, Ibadan. i + 199pp*
- Udofia, T. M., and Edem, U. P. (2019) Meta-cognitive strategy and secondary school students' achievement and retention in Chemistry. *Chemistry and Materials Research*, 2(3), 22-25.
- Ukoh, E. E. (2012). Determining the effect of problem-based learning instructional strategy on NCE pre-service teachers' achievement in physics and acquisition of science process skills. *European Scientific Journal*, 8(17), 74-80.
- Yadav, B., and Mishra, S. K. (2013). A study of the impact of laboratory approach achievement and process skills in science among 1st standard students. *International Journal of Science and Research Publications* 3(1), 1-6