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Effects of Laboratory Learning Environment on Students' Academic Achievement in Chemistry in Senior Secondary Schools

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Abstract

Chemistry is often regarded as a difficult subject by the students. Learning environment is the diverse physical locations, contexts and cultures in which students learn. This study looked at the effect of chemistry laboratory learning environment on student Academic Achievement in chemistry. A satisfied random sampling technique was used to select students from the six (6) educational zones in Anambra State. A total of 300 chemistry students from the six (6) educational zones in Anambra State were sampled. Quasi-experimental design was adopted for the study. Chemistry Achievement Test (CAT) with reliability coefficient of 0.82 using Kuder Richardon – 21 and Chemistry Laboratory Learning Environment Inventory (CLLEI) with a reliability coefficient of 0.85 using Cronch alpha were used for data gathering Mean, Standard Deviation. t-test was used to analyze the data. The results showed that the chemistry laboratory learning environment has a significant effect on students' academic achievement in chemistry. An environment has an effect on the academic achievement of the students. Also there is a significant difference between students' preferred and actual chemistry laboratory learning environments in terms of students' open-endedness, cohesiveness, material, integration, rule clarity. The results also indicated that there is no significance difference or male and female students in the way they perceived the same laboratory learning environment. It is recommended that students should be given the opportunity to work cooperatively, provided with frequent laboratory activities. Better conducive laboratory learning environment will yield better academic achievement in chemistry.

Key words: Chemistry, laboratory, learning Environment.

INTRODUCTION

Chemistry is a branch of science that deals with the composition, structure and behavior of the atoms and molecules that make up all forms of matter. It is very important subject as it cuts across almost all fields of life (Emendu 2018). It contributes immensely to the technological growth of the nation. Hence, any nation that aspires to develop scientifically and technological must pay attention to the quality of chemistry education that is being taught in schools. The study of Chemistry in schools is well pronounced in Senior Secondary school one. It is meant that the student will study chemistry for good three years (SSS1-3) before he/she will take it in school certificate examinations.

The federal Republic of Nigeria (2014) made it clear in the National Policy on Education that science teaching and learning should be activity oriented and student centered such that student acquire relevant laboratory experiences. The achievement of those objectives will depend on and be influenced by the teacher, the students, the materials, the laboratory and how both students and teachers perceive them in relation to intended learning outcomes. Ajiwe (1999) maintained that a chemist should know the materials and equipment he works with.

Abdullahi (2008) defined a laboratory as a place where scientific methods are practiced and where hypotheses and theories are tested .It is also a place that helps students to acquire and improve on their manipulative observation and reasoning skills. The laboratory practicing generally aimed at improving the students' psychomotor skills and the abilities by providing conducive environment for conducting the experiment. In a well designed laboratory, students can engaged and experiment co-operatively with other students and individually. The interaction in the laboratory is always on high increase.

In the views of Obanye (2007), education does not occur in a vacuum. It grows in a social – political economic and scientific environment. Hence, there can be no education without an environment. Akubue (2006), stated that a good learning environment has the advantage of fostering desirable behavior and attitude; developing problem solving, skills and creative thought,

encouraging students' interrelationship and fostering centered methods. School environment reflects the physical and psychological aspect of the school that are more susceptible to change and provide the pre – conditions necessary for teaching and learning to take place (Jungle, 2003). Tshui and Cai (2011), describe learning environment as an orderly environment in which the school family feels valued and able to pursue the schools mission from concern about disruptions and safety. Emendu (2010) observed that the materials around us are putting a lot of challenges to the chemistry teachers. These materials are within the environment. Learning chemistry means not only learning facts and concepts that describe the physical world of matter, but also learning how to examine the physical evidences of chemical principle in a laboratory environment. There is a brief that the knowledge of chemistry to the society is very important, but students' performance in the subject as measured by their scores in senior secondary certificate Examination (SSCE) is very poor.

Laboratory experiences provide opportunities for students to interact with the materials or data drawn from the materials using different tools and equipment. These students' activities include physical manipulation of the real-world substances or system under investigation and interaction with stimulations. Hence, students can work with materials to observe and understand phenomena. Chemistry classroom/laboratories should therefore be designed with the following goals in mind: Motivating students to make more use of science process skills; promoting mastery of subject discipline; allowing more students involvement through inductive approaches than traditional approaches; appearing to be preferred by the students; developing the nature of science and phenomena; appearing to work well for students of all ability levels including both the slow learners and the gifted learners; enhancing science process skills; providing less direction and therefore assign students more responsibility to determine procedural strategies; cultivating interest in science and interest in learning science; producing significantly more educational gains than traditional laboratories; enhancing teamwork abilities; and understanding the ambiguity and complexity of empirical work (Akinbobola, 2011).

Njelita and Emendu (2016), had already looked into the effects of practical activities of chemistry student's science process skills acquisition, and pointed out those practical activities foster students science process skills in chemistry. The laboratory learning environment is the agent of this process of fostering students science process skills. Learning environment is the diverse physical locations, contexts and cultures in which students learn. The emphasis is that the learners must do the learning, the aim is to create a total environment for learning that optunises the ability of students to learn. A learning environment from a teachers perspective include: content (content goals; sources; structure; quantity/depth; activities). Learning support (counseling; scaffolding; feedback; other students); Resources (my time; assistant; facilities; technology); learners characteristics (learners goals; prior knowledge; Digital natives; Diversity; learning contexts) and Assessment (projects; E-portfolios; tests and essay).

The various dimensions of chemistry laboratory learning environment as perceived by the students and the actual laboratory learning environment include open-endedness, cohesiveness, material, integration, rule clarity (Akinbola 2015). Cohesiveness is the extent to which students know, help and are supportive of one another. Open-endedness is the extent to which the laboratory activities emphasize an open-ended, divergent approach to experimentation. Integration is the extent to which the laboratory activities are integrated with non-laboratory and theory classes. Rule clarity is the extent to which behaviour in the laboratory is guided by formal rules material environment is the extent to which the laboratory equipment and materials are adequate. The study therefore is to look at the effect of Chemistry Laboratory Learning Environment on Student Academic Achievement in Chemistry.

Statement of the Problem

In recent time in Nigeria, poor performance of student in chemistry in the senior secondary school certificate examination has generated serious concerns among science education. The perception of students is that chemistry is a difficult subject. One of the factors that contributed to poor performance is the situation of laboratory learning environment. The perception of the students has affected their interest and that led to poor performance in the subject. Teachers are doing best to ensure that the students do well in chemistry. Despite all these efforts, students' learning has remained consistently poor at the senior secondary certificate examination SSCE. However, there seems to be a neglect of important factors such as laboratory learning environment of which this study wants to know the effect on students' academic achievement in chemistry.

Purpose of the Study

The purpose of the study is to find the effect of laboratory learning environment on students' academic achievement in chemistry. Specifically, the study is designed:

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1. to examine the effect of chemistry laboratory learning environment on students' achievement.
2. to ascertain the difference between preferred and actual chemistry laboratory learning environment as perceived by students.
3. to find out the perception of students and teachers in the same laboratory learning environment.

Research Question: In order to achieve the purpose of this research work, the study sought answer to this question.
To what extent do Chemistry laboratory learning environment affects the students learning?

Hypotheses: The following null hypothesis tested at 5% level of significance guided the student.

Ho_1: chemistry laboratory learning environment has no significant effect on students' academic achievement in chemistry.

Ho_2: There is no significant difference between students' perceived and actual chemistry laboratory learning environment in terms of cohesiveness, open-endedness, integration, rule clarity and material.

Ho_3: There is no significant difference between the perception of students and teachers about the same chemistry laboratory learning environment.

METHODOLOGY

Research design: The researcher adopted the quasi-experimental design. The experimental groups were exposed to laboratory learning environment while the control groups were exposed to normal classroom learning environment. Both experimental and control groups were exposed to the topic separation techniques which as contained in the section of the senior secondary school chemicals curriculum meant for SS 1 students in Nigeria. Multiple-choice objective test items were administered to the students in the two groups (experimental and control) as pre and post tests. The pre-test was conducted before the treatment. The treatment lasted for three (3) weeks of the end of which post-test was conducted in all the group3. The pre-test was re-numbered in the post-test to make it look different as face value.

Population for the study:- The population for the study was 48,820 senior secondary one (SS1) students of all government owned co-educational secondary school in Awka Education zone of Anambra State.

Sample and Sampling Technique:- A sample of 300 chemistry student (150 males and 150 females) was drain from three (3) co-educational schools through simple random (balloting) sampling technique from secondary schools in Awka zone in Anambra State, Nigeria. Two intact classes in each of experimental and control and groups (150 students) were exposed to that classroom. The experimental and control groups were taught the topic – separation technique in chemistry by their regular chemistry teachers.

Instrument for Data Collection:- The instruments for data collection were Chemistry Achievement Test (CAT) on separation technique and chemistry laboration learning Environment Inventory (CLEI). The CAT was a 30-item test package, development by the researcher from the content of the study. The CLEI was 25-items package, developed by the researcher from the laboratory learning amount. The CAT and the CLEI were validated by three expects (two in chemistry and one in measurement and Evaluation). The CAT was subjected to Kuder Richardson formular – 21 and the result showed a reliability coefficient of 0.82. The data collected from CLEI were subjected to Cronbach alpha and the result showed a reliability coefficient of 0.85. The items were developed using a test blue-print indicating the topics and numbers of items.

Method of Data Analysis:- Mean with standard derived to answer research question. The formulated research hypotheses were tested using t-test of 0.05 level of significance.

RESULTS

Research Question

To what extent do chemistry laboratory learning environment affects the students learning?

Table 1: Extent the chemistry laboratory learning Environment inventory (CLLEI) affects the students learning.

S/N	ITEM	SD	X	Remark
A	**Open-endedness**			
1	Teacher decide the activities of the students.	6.18	3.10	LE
2	Students decide the activity of the students	1.12	1.11	SE
3	Students prefer using activity set by the curriculum planners.	0.72	3.15	LE
4	Teacher's work is to guide	11.35	3.20	LE

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5	Teachers help to correct the students' misconceptions.	1.70	2.70	LE
6	Students are free to contribute during lesson.	1.11	1.50	SE
B	**Cohesiveness.**			
7	Students prefer to work together cooperatively.	7.18	2.70	LE
8	Students prefer organizing work in the laboratory.	0.66	3.11	LE
9	Students prefer asking questions.	1.52	3.12	LE
10	Students encourage zonal interaction.	1.15	3.11	LE
11	Demonstrate self management.	1.80	3.15	LE
12	Facilitate better study habit.	1.00	3.10	LE
13	Facilitate retention of knowledge.	3.01	3.11	LE
C	**Material**			
14	Materials are available in fully supply.	0.52	1.20	SE
15	The material are real	1.31	1.05	SE
16	Material provide first hand experiences	2.42	2.25	SE
17	Materials develop creative ability of learners.	0.35	2.72	LE
18	Material promote innovation	6.10	3.11	LE
D	**Integration.**			
19	Teacher integrates theory with the practical activity.	6.20	2.15	SE
20	Theory and practical takes place at different time.	7.11	2.16	SE
21	Practical are always done in the laboratory.	7.25	2.17	SE
22	I interact with other students during practical activities in the laboratories.	5.28	2.30	SE
E	**Rule Clarity**			
23	Safety is sure during practical	6.72	2.50	LE
24	Students have learnt how to handle the laboratory equipment.	6.11	2.50	LE
	Students take good care of the equipment.	6.15	2.53	LE
25	Rules and regulation guiding laboratory activities are kept in the laboratory.	5.90	2.62	LE
26	Enough space is there in the laboratory	4.89	3.81	LE

From table 1, it shows that the students are free to contribute during lesson, materials are available in final supply, the materials are real, material provide first had experiences, teacher integrates theory with the practical activity, theory and practical take place at different time; practical's are always done in the laboratory, and teachers interact with other students during practical activities in the laboratory with small extent (SE) of 1.11, 1.50, 1.20, 1.05, 2.25, 2.15, 2.16, 2.16, 2.17, 2.30 respectively while they respond to large extent on the rest of the items.

Hypothesis One

Chemistry laboratory environment has no significant effect on students' academic achievement in chemistry.

The analysis is as shown in Table 2.

Table 2: Analysis of the effect of chemistry laboratory environment on students' academic achievement

Variable:	N	X	SD	DF	t-cal	f-cuit	Decision
Laboratory	150	76.85	4.33				
Experiment				2.98	3.13	1.96	9.35
Control	150	54.52	4.01				

* = Significant at p<.05 alpha level.

The analysis in table 2 shows that, the calculated t-value of 9.35 is greater than the critical t-value of 1.96 at p<.05 alpha level. Therefore, the null hypothesis which stated that chemistry laboratory environment has no significant effect on students' academic

achievement in chemistry subject is rejected. This implies that chemistry laboratory environment has significant effect on students' academic achievement in chemistry.

Hypothesis Two

There is no significant difference between students' preferred and actual chemistry laboratory environment in terms of student cohesiveness, open-endedness, integration, rule clarity and material environment.

The analysis is as shown in Table 3.

Table 3: t-test analysis of students' preferred and actual chemistry laboratory environment

Laboratory Environment	N	X	SD	DF	t-cal	t-critical	Decision
Open-endedness							
Actual	150	2.17	4.25	298	2.91	1.96	*
Preferred	150	3.98	4.78				
Cohesiveness							
Actual	150	2.92	3.42	298	2.43	1.96	*
Preferred	150	3.64	493				
Material Environment							
Actual	150	2.52	3.84	298	2.11	1.96	*
Preferred	150	3.20	4.24				
Integration							
Actual	150	2.25	4.59	298	2.39	1.96	*
Preferred	150	2.72	7.14				
Rule Clarity							
Actual	150	2.88	4.20	298	2.23	1.96	*
Preferred	150	2.24	4.96				

* = Significant at p<.05 alpha level.

The analysis in table 3 shows that, the calculated t-value of 2.91, 2.11, 2.43, 2.39 and 2.23 for open-endedness, cohesiveness, material, integration and rule clarity respectively is greater than the critical t-value of 1.96. Thus, the hypothesis which stated that, there is no significant difference between students' preferred and actual chemistry laboratory environment in terms of cohesiveness, open-endedness, integration, rule clarity material is rejected. This implies that, students' preferred chemistry laboratory environment is different from the actual chemistry laboratory environment.

Hypothesis Three

There is no significant difference between the perception of male and female students about the same chemistry laboratory environment.

The analysis is as shown in Table 4.

Table 4: t-test analysis of the perception of students and teachers about the same chemistry laboratory environment

Perception	N	X	SD	DF	t-call	t-critical	Decision
Male	12	3.71	4.35				
Female	150	3.65	4.92	160	0.54	1.96	NS

NS = Not significant at P < .05 alpha level.

The analysis in Table 4 shows that, the calculated t- value of 0.54 is less than the critical t-value of 1.96. Therefore, the null hypothesis which stated that, there is no significant different between the perception of students and teachers about the same chemistry laboratory environment is retained. This implies that, both the teachers and students perceived the present status of chemistry laboratory environment in Anambra State of Nigeria in the same way.

DISCUSSION

The present situation in the laboratories is a stereotyped one which makes the teacher to decide the activities to be carried out by the students as indicated in table 1. However, the students prefer using activity curriculum in which students can pursue their own interest based on their needs and aspiration with the provision of variety of activities by the teachers. Students are not free to contribute their idea during lesson. This will provide an open-ended divergent approach to experimentation. This is in agreement with the findings of Ajewole (2005) that curriculum projects were developed and accomplished through the close collaboration of teachers and scientists. Emendu (2018) indicated that each component of the curriculum influences the other.

The form of cohesiveness that the students preferred is to work together. This might be due to the fact that, working together cooperatively enhances appropriate behaviour in organizing work, asking questions, encouraging social interaction, demonstrating self management and facilitating better study habit and retention of knowledge. Adebola and Onakoya (2013) emphasis that cooperative learning is an instructional strategy in which learners work together in small group in such a manner that each member of the group can participate in a clearly collective rack. They believed that cooperative learning engage the learner in discussion with one another while participating in authentic learning activities relevant to real life and that encourage them to teach one another. This is in line with the findings of Akinbobola (2015) that working in small group enhances performance; promote learning and skills, and improvement of self-development through collaborative learning.

The form of material that the students preferred is significantly different from the actual material available in terms of chemical tools and equipment. Most of the materials available are in short supply and this make the practical activities to be crowded. Onweh (2005) discovered that many schools do not have the relevant tools and equipment for studying the practical. The students preferred form of material that make teaching to be real, provide first-hand experiences, develop creative ability of learners, and promote innovation and learning by doing. This is in line with the findings of Akinbobola (2015) that, good laboratory environment enhances hands-on activities and enable the students to acquire basic science process skills in order to solve problems.

The form of integration that the students preferred is the type that the practical activities are integrated with theory. The actual situation is that, the theory and the practical activities take place at different time. Most often, the practical activities are delayed until the final external examination is near. Integration of practical activities with theory enhances the development of science process skills and the ability of students to arrive at generalizations or concepts. That means integrating practical work with theory enable students to develop the habit of critical thinking, innovation and creativity.

The form of rule clarity that the students preferred is the type that student's safety and proper handling and care of equipment is ensured. The teacher should prepare the rules and regulations guiding laboratory activities and make it known to the students.

The results of hypothesis one showed that, chemistry laboratory learning environment has significant effect on students' academic achievement in chemistry subjects. Laboratory settings have also been demonstrated to be effective means for comprehension, understanding and application of scientific knowledge. Inquiry method and varieties of activities in a good chemistry laboratory environment provide students' many opportunities to observe, sample, experience and explain with scientific phenomena in their quest for knowledge of nature.

The result of hypothesis two showed that, students' preferred chemistry laboratory learning environment different from the actual chemistry laboratory learning environment in Anambra State of Nigeria. The result also indicated that, the significant difference exists between students' preferred and actual chemistry laboratory learning environment in terms of open-endedness, cohesiveness, material, integration and rule clarity respectively in favour of preferred science laboratory environment.

The results of hypothesis three showed that, both the male and female perceived the status of chemistry laboratory learning environment in the same way. This might be due to the fact that, both the students recognize the problems facing the chemistry laboratory learning environment which include shortage of tools, materials and equipment and lack of maintenance culture so

gender has no effect on laboratory learning environment. This in agreement with the findings of Akinbobola (2007) that, the major problem facing laboratory environment is improper maintenance of materials and equipment.

CONCLUSION

This study shows that the Chemistry laboratory learning environment has significant effect on students' academic achievement in chemistry. There exists a significant difference between students' preferred and actual chemistry laboratory learning environment in terms of open-endedness, cohesiveness, material, integration and rule clarity respectively. Better conducive laboratory learning environment will yield better academic achievement in chemistry.

RECOMMENDATIONS

In view of the implication of the findings from this study, the following recommendations are made:

1. Adequate chemicals and equipment should be provided in the laboratory in order to promote creativity, innovation and learning by doing.
2. Adequate space should be provided in order to ensure free movement of students and teachers that is having a standard laboratory.
3. In – service training should be enhanced through organizing regular seminars, workshops and conferences for teachers.
4. Safety rules and regulations guiding laboratory activities and procedures should be made known to the students.
5. Students should work collaboratively with other students in order to enhance appropriate behaviour in organizing work and social interaction, and facilitating better study habit and retention of knowledge.
6. Laboratory activities should be integrated with theory during regular class period by the chemistry teacher.

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