EFFECTS OF CO-OPERATIVE LEARNING STRATEGY AND DEMONSTRATION METHOD ON ACQUISITION OF SCIENCE PROCESS SKILLS BY CHEMISTRY STUDENTS OF DIFFERENT LEVELS OF SCIENTIFIC LITERACY

BY

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Abstract
The study investigated the effects of co-operative learning strategy and demonstration teaching methods on acquisition of science process skills by chemistry students of different levels of scientific literacy. The design of the study was quasi-experimental of pre-test post-test non-equivalent control group. The sample consisted of one hundred and forty five senior secondary two chemistry students drawn from six randomly sampled schools in Onitsha Urban Area of Onitsha Education Zone in Anambra State. Two research questions and two hypotheses guided the study. Treatment involved teaching selected chemistry concepts to the experimental group using co-operative learning strategy while the control group was taught using demonstration teaching method. Science process skills acquisition test (SPSAT) and Scientific Literacy Test (SLT) were the instruments for data collection. Mean and standard deviation were used to answer the research questions while Analysis of Covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance. Results revealed that students taught using co-operative learning strategy performed significantly better than those taught using demonstration teaching methods. There was no significant interaction between teaching methods and scientific literacy levels of chemistry students on science process skills acquisition. Based on the findings, the use of co-operative learning strategy to enhance science process skills acquisition in chemistry students was recommended to chemistry teachers.

Introduction

Science process skills are taught as part and parcel of the chemical practical skills in chemistry curriculum. They are activity-based skills which can be acquired through training and direct experience. The acquisition of all science process skills by students is influenced by the cognitive knowledge-based of the students.

Science process skills (SPS) are cognitive and psychomotor skills which scientists employ in problem identification, objective inquiry, data gathering, transformation, interpretation and communication. Harlen (1984) describes science process skills as abilities which can be developed by experience and which are used in carrying out material operations and physical action. Studies by Ibe & Nwosu (2003) and Okoli (2006) assert that when one acquires the science process skills of observing, measuring, questioning, designing experiments, interpreting data etc, such a person becomes specially equipped with the tools required for scientific inquiry or problem solving as well as ability to use these skills in the laboratory for a variety of investigation. Laboratory skills are synonymous in many ways with science process skills. Hence, instructional strategies that enhance the acquisition of science process skills also enhance the acquisition of laboratory skills. In the same vein, Adnam (1988) said that process skills in science provide learners with opportunities to use scientific equipment to develop basic manipulative skills, practice investigative or inquiry activities and develop problem-solving attitudes needed for future work in science. How far these and other objectives of processes in science activities are achieved depends on a numbers of factors such as studentsô ability levels, availability of relevant equipment and materials and the approaches adopted for carrying out the activities (Njoku, 1999).

Studies have indicated that students exhibit very poor science process skill acquisition (Igboegwu, 2006; 2006 and Nwosu, 2006). This poor acquisition has been attributed to a number of factors such as teacher variable, that is, the teacherôs method of teaching. Njelita (2007) found out that innovative teaching strategies such as (inquiry, problem, solving, co-operative, demonstration methods are better than the conventional method in acquisition of science process skills.

However, other factors such as level of intelligence of the teacher, socio-economic status of parents and learner characteristics such as scientific literacy level contribute to students acquisition of process skills in chemistry even when novel teaching methods are used. Based on this, the study tries to investigate the effects of co-operative learning strategy and demonstration teaching methods on acquisition of science process skills in chemistry using studentsô scientific literacy levels as criteria.

Co-operative learning is a process of working together in a group to accomplish shared goals (Okoli, 2009). Teachersô use co-operative learning strategy to enhance studentsô ability of working together. By working together, they maximize their own and each otherôs learning. Demonstration method is a teaching strategy that involves experimentation which can be carried out by the teacher for students to observe or participate or by a student for both the teacher and other students to observe. When science process skills are acquired by students through these strategies, it shows a mark of scientific literacy.

Scientific literacy according to Olufolajini (1985) relates to the functional attributes of a science teacher while Arons (1983) tried to characterize a scientifically literate person as one who knows something about the nature and limits f science and the scientific method. In other words scientific literacy means the use of scientific knowledge acquired by an individual to solve personal and societal problems. However, this researcher tries to examine the scientific literacy of secondary school chemistry students in order to see how it affects their acquisition of science process skills.

Statement of the Problem

For years now, a number of teaching strategies (inquiry, discussion, discovery, co-operative, demonstration, concept-mapping etc) have been employed in teaching chemistry but performance in SSCE chemistry examinations continued to be poor. This raises some doubts as to whether there are other variables like the scientific literacy level that inhibit the acquisition of science process skills of students in chemistry. Hence, this study seeks to:

- Establish the effect of the co-operative learning strategy and demonstration method of teaching chemistry on level of acquisition of science process skills by chemistry students of different levels of scientific literacy.
- Find out the interactive effects of teaching methods and scientific literacy levels on chemistry students level of acquisition of science process skills

Research Questions

The following research questions guided the study.

- How do teaching methods (co-operative learning strategy and demonstration method) affect acquisition of science process skills of senior secondary school year II (SSII) chemistry students of different levels of scientific literacy?
- How do teaching methods interact with scientific literacy levels of students in acquisition of science process skills?

Research Hypotheses

To guide the study, two null hypotheses were formulated and tested at 0.05 level of significance.

- There is no significant difference in the mean scores on the level of acquisition of science process skills of students of high, medium and low levels of scientific literacy taught chemistry concepts using co-operative learning strategy and those taught the same concepts using demonstration teaching methods.
- There is no significant interaction between teaching methods and scientific literacy levels on acquisition of science process skills.

Research method

Design

The design of the study was quasi-experimental, specifically, the pre test, post-test non-equivalent control group. This design was used because intact classes were employed as it was not possible to randomly assign students to experimental and control conditions because of the administrative set-up of schools.

Sample And Sampling Techniques

The sample comprised one hundred and forty-five (145) senior secondary two (SS II) chemistry students drawn from six intact classes randomly sampled from six out of twenty-two (22) secondary schools in Onitsha urban Area of Onitsha education zone of Anambra State. Two all boys, two all girls and two co-education schools were drawn by stratified and simple random sampling technique. One all boys, one all girls and one co-education schools

were assigned to experimental schools and the other three schools assigned to the control schools. The experimental schools were taught using co-operative strategy while the control schools were taught using demonstration teaching method. Seventy-eight (78) students were in experimental groups while sixty-seven (67) students were in the control groups.

Instrument

Two instruments were used for data collection, namely:

- Science Process Skill Acquisition Test (SPSAT)
- Scientific Literacy Test (SLT)

The level of acquisition of science process skills was measured using SPSAT. The SPSAT is a 30 item test developed by the researcher based on the chemistry topics taught and which were from SS II chemistry curriculum, namely; thermodynamics. The 30 ï item test was made in two sections. Section A was a practical exercise while section B was of multiple choice type. In section A students were required to demonstrate behaviours such as making careful and accurate observations, manipulative skills, measuring, drawing, labeling correctly, making tables, recording data, interpreting observed data, experimenting, predicting and inferring.

The SPSAT test items were validated using two experts from science education and two from measurement and evaluation department in Nnamdi Azikiwe University Awka and Nwafor Orizu College of Education Nsugbe. The instrument was also given to two chemistry teachers in secondary school. The reliability of the instrument was established using cronbach alpha and a reliability index of 0.89 was obtained.

The scientific Literacy Test (SLT) was a modified scientific literacy test developed by Nwagbo (2001) and consisted of four sections. Section A and B comprised of multiple choice items based on knowledge and application of science respectively. Section C was comprised of short essay questions based on communication in science. Section D was composed of both positive and negative scientific statements based on appreciation of science. Each of the sections were weighted based on the number of the items thus:

Section A had 14 multiple choice items of 27%
Section B had 12 multiple choice items of 23%
Section C had 5 short essay type items of 20%
Section D had 15 scientific statement items of 30%

The total score for each student of the scientific literacy test was collected as percentage score and this formed the basis for categorizing students into levels of scientific literacy as follows:

70% and above ï High level of scientific literacy
50% - 69% - Medium level of scientific literacy
0% - 49% - Low level of scientific literacy.

Procedure

The regular chemistry teachers in the selected schools who were trained by the researcher were used for the study. Each teacher was given a copy of validated lesson plan as well as copies of the two instruments used for the study. The scientific Literacy Test (SLT) was administered only as pre-test and was used for categorizing students into high, medium and low levels of scientific literacy according to the specification given by the researcher. After this, the Science Process Skill Acquisition Test (SPSAT) was administered as a pre-test and the scores noted before the commencement of the treatment

The main treatment for the study was teaching using co-operative learning strategy and demonstration method which lasted for six weeks. The experimental groups were taught a chemistry concept (thermodynamics) using the co-operative learning strategy. This involved grouping the students into four or five groups. Each group was provided with instructional materials needed for the lesson. The teaching featured introduction of the topic, drawing attention of each group to the instructional materials, guiding each group to find solution to the problem at hand, allowing each of the group to ask questions to the group members and draw their conclusions and directing each group in consistencies. Each activity is followed by class discussion, which featured contributions and further questions from groups.

The control groups were taught the same concept using demonstration teaching method, the regular chemistry teacher delivered the pre-planned lesson to the students with the use of the instructional materials. She/he proceeded directly to the task of solving the problem. Interaction between the students and the teacher was minimal and the students listened and assimilated principles and procedures for the correct solution of the problem. Immediately after the treatment, the science process skill acquisition test was administered the second time as a post-test.

Results

Data for answering research questions were obtained by computing the pre ï test and post-test mean and standard deviation (SD) scores of students, while the Analysis of covariance (ANCOVA) was used to test the null hypotheses at 0.05 level of significance with the pre-test scores as covariates. The results are presented in the tables.

Table 1: Pre-test and Post-test mean and standard deviation scores of students in Science Process Skill Acquisition Tests due to Teaching Methods and Scientific Literacy levels.

Teaching Methods	**Type of Test**	**Scientific Literacy Levels**					
		High		**Medium**		**Low**	
		X	SD	X	SD	X	SD
Co-operative	Pre-test	37.76	7.88	36.65	5.00	34.85	9.65
	Post-tes	71.52	8.31	62.16	14.27	56.06	9.75
Demonstration	Pre-test	39.99	15.13	35.11	10.88	34.36	11.34
	Post-test	64.25	14.14	57.63	15.31	52.14	11.55

The results in table 1 showed that the two teaching methods has remarkable effects on the students level of acquisition of science process skills. Students in the high level of scientific literacy group exposed to co-operative learning strategy had higher mean science process skill acquisition score than those in the medium and low level of scientific literacy group respectively. While students in the medium level scientific literacy group had higher mean science process skills acquisition score than those in the low level scientific literacy group.

In the demonstration group, students in the high scientific literacy level group had higher mean science process skills acquisition score than those in the medium and low level scientific literacy groups. Also students in the medium level scientific literacy group had higher mean science process skills acquisition scores than those in the low level scientific literacy group. The results also showed that the students exposed to the teaching methods, the higher their scientific literacy level, the higher their level of acquisition of science process skills in chemistry.

Table 2: Mean and standard Deviation scores of students' overall Post science Process Skills Acquisition in chemistry due to teaching methods and scientific literacy levels.

Teaching methods		**Scientific Literacy Levels**		
		High	**Medium**	**Low**
Co-operative	N	14	30	34
	X	71.52	62.16	56.06
	SD	8.31	14.27	9.75
Demonstration	N	24	20	23
	X	64.25	57.63	52.14
	SD	14.14	15.31	11.55

The results in table 2 revealed that all levels of scientific literacy students exposed to the co-operative learning strategy recorded higher mean science process skills acquisition scores than those exposed to demonstration teaching method. The results further showed that there was no interaction between teaching methods and scientific literacy level on acquisition of science process skills in chemistry.

The two hypotheses for this study were tested using Analysis of covariance (ANCOVA) at 0.05 level of significance.

Table 3: Analysis of covariance (ANCOVA) of studentsô overall science process skills acquisition scores by teaching methods and scientific literacy levels.

Source of variation	Sum of Squared	F	Mean Square	F	Sign. F
Covariates					
Pre-test	7077.272	1	7077.272	39.848	0.000
Main effects	2870.295	3	956.765	4.517	0.001
Teaching methods	514.760	1	514.760	3.675	0.084
Scientific Literacy Level	2003.468	2	1001.734	6.063	0.001
2-way interaction					
Teaching method Sc. Literacy level	174.780	2	87.390	0.595	0.636
Explained	12810.542	6	2135.090	16.436	
Residual	22331.196	138	161.820		
Total	35141.738	144	244.040		

For hypothesis for (HO_1). The results as indicated in table 3 revealed that the main effect teaching methods has an F-value of 3.675 at 1 and 138 degrees of freedom. This is significant at 0.05 level of significance. Hence the hypothesis of no significant difference in the level of acquisition of science process skills by students of different levels of scientific literacy taught chemistry concept using the co-operative learning strategy and those taught the same concepts using the demonstration teaching method was rejected. Also data on table 3 revealed that the main effect scientific level had an F-value of 6.063 at 2 and 138 degrees of freedom. This also was significant at 0.05 level of significance. These results imply that there was significant difference in the mean scores on acquisition of science process skills by students of high, medium and low levels of scientific literacy taught chemistry concepts using the two teaching methods as measured by (SPSAT). Hence, the null hypothesis of no significant difference was rejected. The result showed that the students taught using the co-operative learning strategy performed better than those taught using the demonstration teaching method. However, the results showed that the difference in the mean scores due to scientific literacy levels was significant, hence, the SCHEFEE post-hoc multiple compassion test was used to determine the direction of the difference.

Table 4: SCHEFEE Post-hoc multiple comparisons Test Between three mean scores on overall science process skills Acquisition.

Mean		Scientific Literacy Levels		
		Low	Medium	High
54.1034	Low			
61. 395	Medium	*		
67.885	High	*	*	

(*) = Significant difference at 0.05 level of significance.

The results in table 4 revealed that level of scientific literacy (High, Medium, Low) differed significantly from the other with regards to acquisition of science process skills when students are expose to either of the two teaching methods. The result showed that the mean scores on acquisition of science process skills of the low level group differed significantly from that of the medium and high level groups respectively. Also the mean scores of the medium level group differed significantly from the high and low level groups respectively.

Hypothesis two (HO_2) the data on table 3 revealed that the 2-way interaction between teaching methods and scientific literacy levels is 0.595 at 2 and 138 degrees of freedom. The value is not significant at 0.05 level of significance. Hence, the hypothesis of no significant interaction effect between teaching methods and scientific literacy levels on acquisition of science process skills is not rejected.

Discussion and Implications

The findings of this study revealed in table 1 indicate that for the co-operative learning strategy, the high level scientific literacy group had higher mean science process skills acquisition scores than the medium level who in turn scored higher than the low level group. For the demonstration method, the highest mean science process skills acquisition scores was recorded by the high level scientific literacy group, followed by the medium and

low level groups respectively. Furthermore, the results in table 3 also confirmed that the difference in the mean science process skills acquisition scores in chemistry among students of in the high, medium and low levels of scientific literacy in significant. The findings revealed that the higher the scientific literacy level of the students, the higher their acquisition of science process skills in chemistry for the teaching method.

Studies abound in literature on the effects of teaching methods on achievement and science process skills acquisition (Ibe & Nwosu, 2003; Damole & Adeoye 2004; Akubuilo, 2004). None of these studies used the different levels of scientific literacy of students as criteria. However, Okoli (2006) investigated the effect of investigative laboratory approach and expository method on acquisition of science process skills by biology students on different levels of scientific literacy. The present study found that co-operative learning strategy enhanced science process skills acquisition in chemistry among students of different levels of scientific literacy better than the demonstration method. Also the finding of this study indicated that there was no interaction between teaching methods and scientific literacy levels on acquisition of science process skills in chemistry. From the findings of this study, it can be deduced that teaching students using the co-operative learning strategy enable students to acquire not only scientific knowledge but also science process skills. This implies that chemistry teachers should use the co-operative learning strategies which expose the students to hands-on-minds-on scientific activities, rather than the demonstration method which discourage interaction. There is however, no particular best method of teaching but science teachers in general and chemistry teachers in particular need to adopt a method that has the potential for enhancing acquisition of scientific knowledge and skills as well as fostering creativity in the learners.

Conclusion

The findings of this study revealed that the use of co-operative learning strategy for teaching chemistry concepts to students at different scientific literacy levels enabled them to acquire science process skills better than using demonstration method of teaching. There was no interaction effect of scientific literacy levels and teaching methods on chemistry studentsô acquisition of science process skills.

Recommendations

Based on the findings, the following recommendations were made:

- Government should utilize the services of various bodies such as Science Teacher Association of Nigeria (STAN), Faculties and Institutes of Education in Universities to organize in-service training programmes, workshops, seminars and conferences for serving chemistry teachers to update their knowledge on the use of innovative teaching methods that can enhance studentsôacquisition of science process skills.
- Science educators and curriculum planners should incorporate innovative strategies (co-operative learning strategy) into their various teaching education programmes.
- Government should provide conducive learning environment by providing adequate chemistry classrooms as well as properly equipped chemistry laboratories to enhance the acquisition of science process skills by chemistry students.

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