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Full Length Research Paper

The Effect of Guided-inquiry Approach on Senior Secondary School Students' Academic Achievement in Practical Chemistry in Okrika Local Government Area, Rivers State, Nigeria

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ABSTRACT: To evaluate the influence of guided-inquiry technique on students' academic progress in practical Chemistry, this study used a quasi-experimental design, specifically pre-test, post-test, non-equivalent control group. The study was directed by two research questions and two null hypotheses. A total of fifty SS2 students were randomly selected from seven public secondary schools in the Okrika local government region for the experimental and control groups. Chemistry achievement test (CAT) based on acid-base titration on volumetric analysis was used to obtain results. Two science education professionals verified the instrument. The instrument's dependability was verified using the test-retest method, and the scores obtained were correlated using the Pearson correlation coefficient, which yielded an index of 0.75. The mean (X) and standard deviation (SD) statistics were used to answer the study questions, while the null hypotheses were tested at the 0.05 level of significance using analysis of covariance (ANCOVA). The data analysis results revealed a significant difference in mean achievement scores in favor of the experimental group. Second, in terms of gender mean achievement, males outperformed their female counterparts. It was consequently recommended that Chemistry professors involve their students more in guided-inquiry approaches for better teaching and learning in Chemistry.

Keywords: Guided-Inquiry, demonstration, method, chemistry, students, engagement

INTRODUCTION

One of the science subjects is chemistry. It is a central science subject since it connects all other science courses such as biology, physics, and agriculture. Chemistry plays a role in every part of life, including non-living objects, because every item (alive or non-living) undergoes reaction.

Every object's body is made up of chemical components that undergo chemical or physical reactions, resulting in a chemical or physical change in the object. Furthermore, practically all fields or professions engage in Chemistry directly or indirectly – engineering, medicine, etc. Furthermore, chemical reactions occur everywhere on Earth, including beneath the world, in the sea and other bodies of water, and above the earth, in the firmament, moon, sun, stars, and other celestial bodies. Chemistry, on the other hand, lives with us and works for us in our homes and offices, as well as within us. As a result, the importance of Chemistry to man cannot be overstated.

Furthermore, because chemistry is so important in any nation's scientific (industrial) and technological development, it should be taught and learned in a way that prepares students to deal with concurrent scientific and technological development in order to provide a better life for man in his society. According to Eboka (2014), science, technology, engineering, and mathematics (STEM) education focuses on educating

and physical competence to survive and contribute to the growth of society.

As a result, adopting science teaching and learning approaches geared toward student involvement is a necessary development that any science teacher must embrace as a panacea to meaningful learning in science in particular.

The instructor must ensure that his instruction is effective and that the student is adequately prepared at the end of the school year. By doing so, the learner will receive a comprehensive approach to learning that will result in a grasp of even complex scientific topics, as well as the necessary skills and attitudes to enable him to live and contribute to his community as expected.

For numerous years, the failure rate in Chemistry, notably in the Senior School Certificate Examination (SSCE), has been linked to teachers' inability to select or identify and implement acceptable methods of teaching and learning. Students' poor academic performance in Chemistry has been attributed to teacher-related problems (Giginna and Nweze, 2014). To combat this threat, science teachers must employ instructional approaches that are practical, student-centered, and thought-provoking.

Science Education strongly advises that teaching and learning should be centered on the student. However, it has been noticed that, even at the secondary school level of education, the most common technique of teaching and learning utilized by scientific teachers is the lecture or exposition approach, in which verbal presentation of the subject is the mainstay.

The lecture method of teaching does not encourage the learner to engage in his own thinking; rather, the teacher dictates notes and performs all of the talking, regardless of whether the concepts are accurate or not, while it is the student's responsibility to note down the garbage that he says. The learner has no say in this process, and the pupil is rendered invisible.

It is one method that is concentrated on the teacher. The teacher is the referral who owns all of the knowledge that he exhibits to the learner and draws conclusions from. Whereas modern science argues that teaching and learning approaches should be student-centered and engage the learner throughout, and that the learner should never become invisible or outdated during the learning process?

The demonstration style of teaching is a popular "next choice" for scientific teachers while teaching and learning. A method employed as a method within a method that, while it can be utilized on its own in some cases, does not have the capacity to accommodate the learner's complete participation.

The demonstration method of teaching is known to involve sharing, doing, and illustrating learning methods; thus, it is an activity-based method in which the teacher displays the learning materials and performs the task using sequential instruction to show and explain to the learner the proper procedure for using a particular method.

Without a doubt, if used properly, the method can assist students in identifying and solving problems, as well as proving or clarifying an idea, process, or product. However, it is woefully inadequate for meaningful learning due to the absence of student-centered activities throughout the teaching-learning process. There are several types of demonstrations: teacher demonstrations, teacher-student demonstrations, student demonstrations, and guest demonstrations (Tersco, 2017).

The teacher-student demonstration method enables students to engage with learning materials in order to solve difficulties. However, while the student-teacher-demonstration technique stimulates student participation, it does not provide equitable opportunity for all students/learners to engage with learning materials, because learning resources do not reach all learners. Even when a student performs the demonstration, he only temporarily assumes the position of the teacher he imitates, whose ideas he only repeats after him; he is either not free to exercise his ideas, experiences, skills, creativity, and abilities so that he is not completely engaged with the learning material throughout the learning; and the rest of the students are not engaged with the learning material at all.

To that end, the demonstration style of teaching is a lopsided method of instruction in which only the teacher handles and exhibits the learning materials while also conversing with the students at regular intervals as the students watch and listen. The pupil and learning become inert and/or dormant as the teacher does the practical practice. Teachers must thus educate effectively and efficiently by using science teaching strategies that benefit students, who must be at the center of learning in order to obtain the information, competence, and attitude required.

Guided-inquiry is a teaching method in which students use processes to exhibit the mental and physical behaviors of scientists — scientific attitudes such as objectivity, creativity, honesty, and inquisitiveness.

In general, the inquiry mode of communication aids in the development of skills, long-term recall capacities, and a more positive attitude toward good scientists. The learner acquires a certain method for solving problems and responding to inquiries provided by the environment. Inquiring methods assist learners in observing their environment, formulating questions about problems in their society, developing hypotheses, implementing testing strategies, conducting proper analysis, drawing conclusions from the information, and communicating the same to other members of the society, allowing them to solve societal problems.

In inquiry-based techniques, students work in groups in a learning setting that moves along a timeline. Structured inquiry is a procedure in which students or learners learn discrete science concepts and skills by following the

teacher's scheduled instruction to complete a set of instruction that allows students to engage in hands-on-minds-on-activity. The second phase or path in this teaching is for pupils to respond to teacher-selected questions that will guide him through the problem-solving process.

This is the right guided-inquiry step, and the students are ultimately awoken from the teacher-selected topic to raise their own query, from which they can design and carry out their investigation.

These steps, taken by both the student and the teacher, distinguish the inquiry method and maximize students' learning in science.

Another point of dispute in scientific education and learning is gender imbalance.

Gender equality and women's empowerment are Millennium Development Goals at all levels of education. According to Oloyede (2011), females are disproportionately underrepresented and underachieved in Science, Technology, and Mathematics (STM) subjects. Gender is defined by UNESCO (2014) as the degree of imbalance between male and female access and participation in scientific and technology courses, or the gap between male and female gross enrolment in science and technology courses.

However, Ajayi and Ogbeba (2017) discovered no significant differences in male and female stoichiometry achievement using hands-on activities.

However, because the guided-inquiry approach is designed to encourage students' full participation in their learning, which is lacking in the demonstration method of teaching, this study sought to see how the guided-inquiry approach affected students' achievement in practical Chemistry using acid-base titration of volumetric analysis.

Research questions

The following research questions guided the study:

What is the mean achievement scores of students taught practical Chemistry using guided-inquiry approach and those taught using teacher-demonstration method?

What is the effect of gender on students' achievement in practical Chemistry when taught using guided-inquiry approach and when taught using demonstration method?

Hypothesis

The following null hypothesis was tested at alpha level of 0.05 significance.

Ho1: There is no significant difference in the mean achievement scores of male and female students taught practical Chemistry using guided-inquiry approach and those taught using demonstration methods.

METHODOLOGY

The study is quasi-experimental in nature, with a protest and a non-equivalent posttest control group. The quasi-experimental approach was chosen for this study because intact classes were employed to prevent problems such as rearranging and regrouping students into their outcome courses, as well as disrupting normal classroom learning. The purpose of the pretest was to guarantee that there was no selection bias and to create equality, and to avoid any threat to internal validity.

The study's population is made up of all SS2 Chemistry students in the Okrika local government area of River State, Nigeria (Statistic Unit Post Primary School Board, River State). A total of 130 students comprised the sample. From the 14 public secondary schools in the Obio/Akpor local government, one was chosen as the experimental group (guided-inquiry approach) and the other as the control group (demonstration method). The two schools are similar in many ways, particularly in terms of amenities, and proximity was also taken into account while making this decision.

The instrument used for data collection was Chemistry achievement test (CAT) based on acid/ base titration activities. The instrument consisted of 30 multiple choice questions constructed by the researcher. The research question was answered using mean and standard deviation and the hypothesis was tested using analysis of covariance (ANCOVA) at alpha level of 0.05significance.

RESULTS

Research question 1: what is the mean achievement score of students taught practical Chemistry using Guided-Inquiry approach and those taught using teacher-demonstration method?

The data in (Table 1) revealed that the mean gain achievement scores of students taught using guided-inquiry approach was 4.60 while that of students taught with demonstration method was 3.60. Students taught practical Chemistry using guided-inquiry approach had higher mean gain scores than those taught using demonstration method.

Research question 2: What is the effect of gender on students' achievement in practical Chemistry when taught using guided-inquiry approach and when taught using demonstration method?

Hypothesis: There is no significant difference in mean achievement scores of male and female students taught practical Chemistry using guided-inquiry approach and those taught using demonstration methods.

Data in (Table 2) showed p (1.129), =0.313 therefore p>0.05 thus the null hypothesis that there is no significant

Table 1: Mean and standard deviation of achievement scores of students using guided-inquiry approach and that using demonstration method.

Group	No. of Cases	Pre-test		Post-test		Mean gain
		Mean	SD	Mean	SD	
Experimental	70	6.74	3.087	11.34	2.543	4.60
Control	60	8.33	2.820	11.93	2.049	3.60

Table 2: ANCOVA on chemistry students taught practical Chemistry using guided-inquiry approach based on gender

Source of Variation	Sum of squares	df	Mean square	F	Significance
Corrected Model	27.123	4	6.781	1.218	0.306
Intercept	2365.485	1	2365.485	425.052	0.000
Pre-test score	.789	1	0.789	0.142	0.707
Gender	14.553	1	14.553	2.615	0.105
Group gender	1.744	1	1.744	0.313	0.577
Error	695.647	125	5.565		
Total	18262.000	130			
Corrected total	722.769	129			

difference in mean score of male and female students taught practical Chemistry using guided-inquiry approach and those taught using teacher-demonstration method is not rejected.

DISCUSSION

Students taught using guided-inquiry approach performed better than students taught using demonstration method. The higher achievement score revealed in students taught using guided-inquiry approach might have been connected to the fact that this approach is practical oriented as well as student-centered.

The guided-inquiry approach encourages the students to be actively engaged with the learning materials and by so doing motivated them to learn better which has led to the higher achievement score while the demonstration method particularly the type that allows only the teacher to handle the learning material completely makes the learner passive in the learning and so does not allow him the privilege to be fully involved in the learning and this can also limit his knowledge gain of the content presented for the learning and might as well resulted to students in the demonstration method group inability to perform equally with their counterparts. Therefore, guided-inquiry approach is a better approach to learning of particularly practical Chemistry than demonstration method of learning.

This is in line with the study of Bamidele (2015) and Ekomaye (2019) whose separate studies showed students high performance in guided-inquiry. In the same vein a literature review by Bamidele, (2015) revealed that inquiry-based learning enhanced significantly better than those taught using demonstration method This achievement no doubts is because of engagements of students during the learning session which is said to help students grasp and understand content knowledge and creates atmosphere of overall engagement.

However, Ekeyi (2013) conducted a study on the effect of teacher demonstration method on students' achievement in agricultural science compared to lecture method and discovered demonstration method having better students' achievement which may simply imply that demonstration method is a method used within methods as such could be used alongside other student activity based methods such as guided-inquiry approach but should not stand alone as a teaching method if students bet The results also revealed a substantial difference in male and female students' achievement in practical Chemistry when taught through guided inquiry versus when taught by demonstration. This study is in line with Agommuah and Ndirika (2017) who found significant difference in academic achievement between male and female students.

Conclusion

The guided-inquiry method engages the learner with learning resources. Though certain demonstrative techniques of teaching allow students to engage with learning materials, they cannot be said to provide students' active participation as the guided-inquiry approach does. This is one of the reasons why modern science education favors a guide-inquiry approach to teaching and learning. When a guided-inquiry technique is used to teach practical Chemistry, there is no gender discrepancy in achievement between male and female students.

Recommendations

From the study the following recommendation are made:

Science teachers should ensure that teaching and learning of science is done in an atmosphere that encourages student active engagement all through learning session.

Government and educational ministries should provide standard laboratories and equipment and always ensure that they are in good conditions for all science learning for all institutions.

Science students should endeavor to equip themselves with all necessary skills in carrying out scientific process and also be creative in the approach to learning of science subjects.

Parents especially those whose children are at the foundational level of learning should timely assist in providing for their children the necessary materials to equip them with current scientific and technological information.

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