Effect of Guided Discovery Method of Instruction And Students’ Achievement in Chemistry at the Secondary School Level in Nigeria

Author
Omiko Akani
Department of Science Education, Faculty of Education Ebonyi State University, Abakaliki Nigeria
E-mail: akaniomiko@gmail.com

ABSTRACT
This study aimed at determining the effect of Guided Discovery Instruction Strategy on students achievement in chemistry at the secondary school level. Quasi experimental design was employed in the study. The sample for the study comprised 201 SS3 chemistry students from Afikpo Education Zone of Ebonyi State of Nigeria. One intact class was randomly selected and assigned to either control or treatment group. The treatment group was taught with guided discovery instruction strategy while the control group was taught using mean and standard deviation and analysis of covariance (ANCOVA). The findings revealed that Guided Discovery Instruction Strategy was more effective than the conventional method in promoting chemistry students’ achievement in chemistry, and that there was no interaction effect between gender and guided discovery instruction strategy. Based on these the researchers made the following recommendations: the Science Teachers Association of Nigeria (STAN) and curriculum planners should organize workshops, conferences and seminars for the science teacher on the use of GDIS in teaching science and particularly chemistry, the teacher training institutions and universities should include the GDIS in their curriculum and encourage its usage by the students, the use of conventional method of instruction should not be allowed in teaching science, particular chemistry, and textbook authors should in clued guided discovery principles in setting some of the study questions in their science textbooks.

Key words: Guided, Discovery, Strategy, Achievement and Chemistry.

INTRODUCTION
An effective educational system has been variously defined around certain intoned parameters such parameters according to Mogbo (2004). Include;

- A system that is able to bring about desired students behaviours, abilities, habit and characteristics.
- A system where the teacher is imbued with the personal qualities or characteristics of communication skills, rapport with colleagues, responsiveness of parents, good education and innovativeness.
- A system that is able to bring about sound adjustment of the child in the society to which he/she belongs.
- A system in which the teacher has good teaching experience, knowledge of the subject matter, favourable attitude towards teaching and adequate knowledge of teaching methodology.
- A system that is able to relate learning activities to the development process of the learners and to their current and immediate interest and needs.

To achieve effective science education in our country, we need to change the science and technology curricula, and emphasis has to shift from content to processes of science (Omiko, 2016). This would also lead to changes in instructional techniques. Otobo (2012) observed that the need for curriculum changes in education in recent years has led to consequent shift of emphasis from content to processes of science; from
the traditional chalk and talk (lecture) method to modern methods of teaching science such as activity-oriented method of instruction, laboratory method, concept-mapping, enquiry method, guided discovery method of instruction among others. In these modern methods of science instruction emphasis is on changing students’ attention from being passive receivers of information to active manipulators and users of concrete materials during instruction. This means that the students are involved actively in the learning process by themselves.

Ajunwa in Ezejitu (2009) and Otobo (2012) observed that students by nature are investigators; they have the tendency to manipulate materials and are curious to find out what happens. Ezejitu (2009) noted that most activities of young children are underlined by tireless curiosity and a desire to find out through personal exploration. Nwoji (1999) in his contribution, maintained that despite changes in theories of instruction and designs of curriculum, there is unanimous agreement that children are likely to acquire scientific and technological skills that will enable them solve problems associated with human needs and self-reliance by experiencing science through first hand experience in handling concrete materials themselves during lessons. The recent reforms in science and Technology curricula involve creating enabling environment and opportunities for students to interact with one another and the instructional materials during lessons. Eniayeju and Danjuma, (2008), enjoined science teachers to create circumstances for students to interact with each other and to use a number of teaching techniques that could arouse interest and curiosity, provide information and help formulate codes of behaviours.

Massials (1991) observed that discovery method of instruction is a process of self-learning whereby students generate concepts or principles and ideas with very little intervention from the teacher. Discovery according to Otobo (2012) is a psychological construct that is based on the need to provide relevant motivation for students to participate in the generalization of new ideas related to the subject of instruction. Gbamanja (1991) state that discovery occurs when a learner is involved in utilizing his/her mental processes and physical activity to mediate, discover, or grasp some principles, concepts or ideas in various situations. Generally, in teaching and learning situations, discovery method of teaching is a problem solving method that is meant for self-development and sustainability. It enables the learners to identify an objective, plan for its actualization and with a little help or guidance from the teacher (Ezejitu, 2009 and Otobo, 2012).

In science education, guided discovery method of teaching is believed to increase retention of materials learnt because the learner organizes the new information and integrates it with the information or knowledge that has already been accumulated and stored. Learners under normal circumstance, act as investigators in a challenging learning environment; in doing this, Gallenstain (2004) observed that the learners usually place a newly introduced object in a category that they have previously discovered or identified. Omiko (2001), Ali in Ezejilu (2009) and Otobo (2012) noted that one of the ways of making teaching interesting is through the use of the discovery method. The discovery method of teaching and learning of science encourages the learners to be actively involved in finding out on their own, the procedure, principles and concepts involved in any topic, and this will subsequently aid them in carrying out problem solving in any topic. In agreement with this Chikamai (1998) and Otobo (2012) stated that of all the strategies used in teaching science, the discovery method tends to attract most students attention.

However, because of the importance of science and technology education in our national development and sustainability, the researchers were motivated to carry out a study on Guided Discovery method of instruction and students achievement in chemistry at the secondary school level in Ebonyi State of Nigeria.

**PURPOSE OF THE STUDY**

This study was aimed at determining the effects of guided discovery instruction strategy on students’ achievement in chemistry at the secondary schools level in Nigeria. Specifically the study intends to determine:
1. Whether using guided discovery instruction in teaching chemistry will lead to differential achievement in mean score among chemistry students in Afikpo Education Zone of Ebonyi State of Nigeria.
2. Whether using guided discovery instruction strategy in teaching chemistry will lead to mean score difference between male and female chemistry students.
3. Whether using guided discovery instruction strategy in teaching chemistry will lead to interaction differences between the mean scores of gender and guided discovery instruction strategy in chemistry education.

RESEARCH QUESTIONS
The following research questions guided the study.
1. What is the effect of guided discovery instruction strategy on the mean achievement scores of students in chemistry education?
2. What is the effect of guided discovery instruction strategy on gender (Male and female) students in Chemistry Education?
3. What is the interaction effect of gender and teaching method on students achievement in chemistry taught using guided discovery instruction strategy?

HYPOTHESES
The following null hypotheses were formulated to guide the study; they were tested at alpha level 0.05 of significant.
1. There is no significant effect in mean achievement scores of students taught chemistry using guided discovery instruction strategy and those taught chemistry using conventional method
2. There is no significant difference between the mean achievement scores of male and female students taught using guided discovery instruction strategy.
3. There is no significant interaction effect between gender and guided discovery instruction strategy in chemistry Education.

METHODOLOGY
(1) Design of the Study: The design of this study was quasi-experimental. Specifically, pretest-post test non-equivalent control group design was adopted. Quasi-experimental research design is used when it is not possible to randomize individuals or groups to treatment and control groups (White & Sabarwal, 2014). Quasi-experimental design involves selecting groups upon which a variable is tested, without any random pre-selection processes. In carrying out the study, the subjects used in this study were given pretest before treatment was administered. Intact classes will be used. This is to determine effectiveness of the independent variable (treatment) on the dependent variable (achievement).
Where \( X_1, X_2 \) and \( X_3 \) represent Guided discovery (treatment) instruction strategy and control method.
\( O_1 \) Represent pre-tests of the groups
\( O_2 \) Represents Post-tests

(2) Area of the Study
This study was carried out in secondary schools is Afikpo Education Zone of Ebonyi State. The zone is made of five Local Government Areas (Afikpo North, Afikpo South, Ohaozara, Onicha and Ivo Local Government Areas). The zone is located in the southern part of Ebonyi state. It is bonded in the North by Ezza Local Government, in the East by the Cross River State, in the South by Abia State, in the West by Enugu and Imo States. The people are predominantly farmers.
(3) population of the Study
The population of this study comprised twenty thousand six hundred and fifty-eight (20658) SSIII students in public secondary schools in Afikpo Education Zone of Ebonyi State. The choice of the public secondary schools was because all the students in these schools use the same chemistry curriculum. Also the literature reviewed showed that there has not been any known research work on guided discovery instruction strategy done in chemistry in this Education Zone.

Sample and Sampling Technique
The sample for this study consists of 201 SS3 students drawn from 2 co-educational secondary schools out of the seventy-four (74) senior public secondary schools in Afikpo Education Zone. The schools were randomly sampled by balloting. One of the drawn schools was assigned to the treatment group while the other one was assigned to the control group. One intact class was drawn for this study in each school through simple random sampling technique.
The researchers used 94 students in the treatment group, made up of 48 males and 46 females, and one hundred and seven (107), made up of 60 males and 47 females in the control group.

Instrument for Data Collection
The instrument for data collection was the Chemistry Achievement Test (CAT) which was developed by the researchers. The CAT consisted of 20 multiple choice items; each item had 4 options, A, B, C and D. This instrument was used for both pretest and Post-test. The items in the Pre-test were re-organised in numbering and was administered as the post-test.

Validation of The Instrument
The CAT instrument was subjected to both face and content validation by three specialists, one specialist in measurement and evaluation, and the other two in chemistry education. They validated the instrument in terms of clarity of instruction, proper wording of the items, appropriateness and adequacy of the items in addressing the purpose and problems of the study. The test blue-print used in the construction of the items of the test of the instrument was validated also by the three specialists. The test blue print validated by the specialists helped in ensuring content validity of the instrument.

Reliability of the Instrument
The reliability of CAT instrument was achieved by using Kuder-Richardson’s formula-20 (K-R-20). The choice of K-R-20 was based on the fact that it is best used in multiple choice items (Harbour-Peters in Nwafor, 2003; and Otobo, 2012).
The CAT was administered to 45 SS3 students from non-target secondary schools in Onueke Education Zone of Ebonyi State. The reliability co-efficient of pre-test and Post-test of 0.78 and 0.87 respectively were obtained. A total of 20 items were in each of the Pre-test and Post-test, each item was assigned one (1) mark: Thus a total mark of 20mks was obtained for each respondent (students).

Experimental Procedure
The researchers administered the Pre-test to both the experimental and control groups on the first day. After the pre-test, the regular teachers (chemistry teachers) started the treatment in their respective schools. The experimental group was taught using the guided discovery instruction strategy (GDIS) and the control group was taught using the conventional method of instruction (CMI). The treatment was conducted during the normal time table of the school. At the end of the treatment which lasted for 4 weeks, the chemistry teachers administered the Post-test to both the experimental and control groups. Data collected from the Pre-test and Post-test were used to answer the research questions and to test the hypotheses which guided the study.

Control of Extraneous Variables
The researchers made used of the following procedure to ensure that those extraneous variables which may introduce bias into the study were controlled.
(a) Teacher Variable: To control the error which may arise as a result of teacher variables, the researchers organized a Pre-experimental training for the chemistry teachers who were used for the study. These
chemistry teachers were the research assistants and they were also called facilitators. These chemistry teachers were regular teachers teaching chemistry in those intact classes used for the study. Another training programme was also organized for teachers in the two groups (treatment group and control group) and different instructional package was developed for each group.

The training programmes organized for the chemistry teachers helped to establish a common instructional standard among the chemistry teachers. The chemistry topic for this study was treated in details at the respective training session. The researchers also used the opportunity of these training programmes to detect individual problems of the chemistry teachers (Research Assistant or Facilitators), that may introduce errors to the study. It was agreed during the training programme that every specification of the instructional package should be structured to ensure uniformity. The research assistants conducted the treatment in their individual classes. The researchers monitored the study regularly to ensure that the research assistants do not deviate from the normal procedure of the instrument.

(b) Inter-group Variables: In order to eliminate the errors of non-equivalence arising from the non-randomization of the subjects, the researchers used the analysis of co-variance (ANCOVA) for the data analysis

(c) Subject Interaction Variables: In order to control the error that may arise from the treatment and control groups, the researchers did not select treatment and control groups from the same school, to ensure that the students in the treatment and control groups do not mix up ideas. This helped to reduce the errors that could arise from interaction and exchange of ideas among research subjects from the two groups.

**Method of Data Collection**

The researchers administered the Pre-test with the help of the research Assistants. The data collected were marked according to the marking scheme. The scores obtained by the students on the pre-test were recorded and kept for use. At the end of the treatment, the Post-test was administered to the students. The scores obtained in the Post-test were also recorded. Both Pre-test and Post-test scores were analyzed and used to answer the research questions and test the hypotheses that guided the study.

**Method of Data Analysis**

The research questions were answered using mean and standard deviation while the hypotheses were tested using the analysis of covariance (ANCOVA) at 0.05 level of significance.

**RESULTS**

The results of this study are presented in tables according to the research questions and hypotheses that guided the study.

Research Question 1: What is the effect of guided discovery instruction strategy on the mean achievement scores of students in chemistry?

**Table 1:** Mean and Standard Deviation of achievement Scores of Students Taught Chemistry using Guided Discovery Instruction Strategy and those taught Chemistry using Conventional Method.

<table>
<thead>
<tr>
<th>Groups</th>
<th>Types of Test</th>
<th>Mean Score</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment group (taught chemistry using guided discovery)</td>
<td>Pre-test</td>
<td>10.3</td>
<td>3.2</td>
</tr>
<tr>
<td></td>
<td>Post-test</td>
<td>15.1</td>
<td>3.1</td>
</tr>
<tr>
<td>Control group (taught chemistry using conventional method)</td>
<td>Pre-test</td>
<td>7.7</td>
<td>2.7</td>
</tr>
<tr>
<td></td>
<td>Post-test</td>
<td>12.4</td>
<td>3.5</td>
</tr>
</tbody>
</table>

In research question 1, data obtained from the chemistry achievement Test (CAT) administered to both the treatment and control groups were used to answer the research question. Summary of the results are shown on table 1 above. The table shows that both the treatment group and the control group scored lower marks in their pre-tests mean achievement scores than the Post-test mean achievement scores. This implies that both the pre-test and post-test groups made some achievement in the Post-test.
Research Question 2: What is the effect of guided discovery instruction strategy on gender in chemistry education?

**Table 2**: Mean Achievement Scores and Standard Deviation of Male and Female Students Taught Chemistry using Guided Discovery Instruction Strategy.

<table>
<thead>
<tr>
<th>Gender</th>
<th>Types of Test</th>
<th>Mean Score</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>Pre-test</td>
<td>9.7</td>
<td>3.4</td>
</tr>
<tr>
<td></td>
<td>Post-test</td>
<td>14.4</td>
<td>3.3</td>
</tr>
<tr>
<td>Female</td>
<td>Pre-test</td>
<td>8.0</td>
<td>2.8</td>
</tr>
<tr>
<td></td>
<td>Post-test</td>
<td>12.0</td>
<td>3.7</td>
</tr>
</tbody>
</table>

Table 2 shows the results of data analysis based on research question two. It indicates that the male students obtained higher mean scores in the Pre-test and Post-test of the Chemistry Achievement Test (CAT) than the female students. The table also indicates that both the scores for the male and female students in the Post-test were higher than the Pre-test results for the two groups.

Research Question 3: What is the interaction effect of gender and teaching method on students achievement in chemistry taught using guided discovery instruction strategy?

**Table 3**: Summary of Interaction Effect between Gender and Teaching Method on Students Mean Achievement Scores in Chemistry

<table>
<thead>
<tr>
<th>Gender</th>
<th>Teaching Strategy</th>
<th>Mean Score</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>Guided discovery Instruction Strategy (GDIS)</td>
<td>15.792</td>
<td>2.744</td>
</tr>
<tr>
<td>Female</td>
<td>Guided discovery Instruction Strategy (GDIS)</td>
<td>14.435</td>
<td>3.277</td>
</tr>
<tr>
<td>Male</td>
<td>Conventional method</td>
<td>13.203</td>
<td>3.430</td>
</tr>
<tr>
<td>Female</td>
<td>Conventional method</td>
<td>11.362</td>
<td>3.454</td>
</tr>
</tbody>
</table>

Results in table 3 above show that the male students taught chemistry using guided discovery instruction strategy (GDIS) obtained higher mean scores than the female students. Also, male students taught chemistry with conventional method obtained higher mean scores than the female students taught chemistry with the same conventional method.

The results on table 3 also indicate that the mean scores of both the male and female students in both groups, taught chemistry with guided discovery instruction strategy (GDIS) obtained higher mean scores than those students taught chemistry with conventional methods. This implies that the guided discovery instruction strategy is superior to the conventional method at the two levels of gender, indicating that there is no interaction between method and gender on achievement in chemistry.

**Hypotheses**

The hypotheses that guided the study are stated below, and their results are placed in table 4.

H01: There is no significant effect in Mean Achievement Scores of Students taught Chemistry using guided discovery instruction strategy (GDIS) and those taught chemistry using conventional method.

H02: There is no significant difference between the mean achievement scores of male and female students taught chemistry using guided discovery instruction strategy in chemistry education.

H03: There is no significant interaction effect between gender and guided discovery instruction strategy (GDIS) in chemistry education.

The results of the three hypotheses (1, 2 and 3) are illustrated on table 4 below:

**Table 4**: Results of Data Analysis and Test of Hypotheses based on Hypotheses 1, 2 & 3

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of Squares</th>
<th>DF</th>
<th>Mean Squares</th>
<th>F</th>
<th>Sig</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Covariant</td>
<td>239.738</td>
<td>1</td>
<td>239.738</td>
<td>25.659</td>
<td>0.000</td>
<td>S</td>
</tr>
<tr>
<td>Main effect</td>
<td>38147.106</td>
<td>5</td>
<td>7629.421</td>
<td>816.588</td>
<td>0.000</td>
<td>S</td>
</tr>
<tr>
<td>Method</td>
<td>130.857</td>
<td>1</td>
<td>130.857</td>
<td>14.006</td>
<td>0.000</td>
<td>S</td>
</tr>
<tr>
<td>Sex</td>
<td>34.185</td>
<td>1</td>
<td>34.185</td>
<td>3.659</td>
<td>0.057</td>
<td>NS</td>
</tr>
<tr>
<td>Method x sex</td>
<td>26.250</td>
<td>1</td>
<td>26.250</td>
<td>2.810</td>
<td>0.095</td>
<td>NS</td>
</tr>
</tbody>
</table>
Based on hypothesis 1 which says that there is no significant effect in mean achievement scores of students taught chemistry using guided discovery instruction strategy (GDIS) and those students taught chemistry with conventional method. Table 4 showed that for the teaching method, the calculated value of f (14.006) is significant at 0.000 level of significant which is less than 0.05 level of significant set for this study. This implies that the null hypothesis is rejected, that is there is a significant difference between the mean scores of SS3 students taught chemistry using guided discovery instruction strategy and those taught using conventional.

Method of Instruction

Hypothesis 2, which says that there is no significant difference between the mean achievement scores of male and female students taught chemistry using Guided Discovery Instruction Strategy (GDIS) in chemistry. Table 4 shows that the calculated f (3.659) is significant at 0.057 level of significance which is greater than 0.05 level set for this study. Therefore, sex is not significant. This indicates that there is no significant difference between the mean achievement scores of male and female chemistry students in Chemistry Achievement Test (CAT). Therefore, we do not reject the null hypothesis.

Hypothesis 3, which says that there is no significant interaction effect between gender and guided discovery instruction strategy (GDIS) in chemistry education, table 4 also shows that for interaction (Method X sex), the calculated value of f (2.810) is significant at 0.095 level of significance which is greater than the 0.05 set for the study. Therefore interaction (Method X sex) is not significant. This implies that there is no significant interaction effect between gender and guided discovery instruction strategy in chemistry education. Therefore, we do not reject the null hypothesis.

DISCUSSION OF FINDINGS

Based on table 4, it shows that there is a significant difference between the mean achievement scores of students taught chemistry using GDIS, and those taught chemistry using conventional method. This difference is as a result of the GDIS used in teaching the students. Table 1 indicates that the students taught chemistry with GDIS, obtained higher mean score of 15.1 than the students taught chemistry using conventional method, who obtained 12.4 in the CAT. This implies that the GDIS approach of teaching chemistry is better than the conventional method of teaching chemistry in secondary schools.

Chikakamai (1998), Ezejitu (2009) and Otobo (2012) stated that guided discovery is a problem solving method which is needed for self-development and that it should be included in everyday study of science. From the findings of this study, it showed that guided discovery instruction strategy is important in teaching and learning of science and technology. Hence it should be used in teaching of science. When students are allowed to discover, identify an objective, plan for its actualization and work towards it with a little guidance from the teacher, they feel happy and become more devoted to their studies (Omiko, 2016).

In table 4, the results also indicate that sex is not a significant factor. The results on table 4 showed that there is no significant difference between the mean achievement scores of male and female chemistry students in the CAT Instrument. This implies that neither the male students nor the female students have any advantage over the other in chemistry Achievement Test (CAT). The results on table 4 indicate that both male and female students achieved equally in this study. The results on table 2 which show that male students obtained a mean score of 14.4 while the female students obtained a mean score of 12.9 had a mean difference of 1.5. This difference in their mean scores is not significant and can be attributed to error. The finding of this study with regard to gender is in agreement with the findings of Eya and Mgboh (1997), Abonyi (1998), Nwafor (2003) Novak (2003) and Otobo (2012), they observed that there is no significant difference between the achievement of boys and girls in science subjects. However, the findings of this study disagree with earlier findings that shown that boys performed better than girls in their achievements.

The results on table 4 show that there is no significant interaction effect between gender and guided discovery instruction strategy in chemistry education. This implies that neither of the instructional strategies (guided discovery instruction nor conventional method favours boys or girls. The indication is that both strategies are equally good in teaching chemistry to both gender (boys and girls). This finding is in agreement with the findings of Maduabum (1995), Nwafor (2003), Igwe (2006) Otobo (2012) and Omiko (2016) who observed that gender and teaching method have no significant interaction effect on students achievement in science.

Recommendations
This study was carried out with the view to find out the effect of Guided Discovery Instruction Strategy (GDIS) on achievement of students in chemistry. Based on the findings, the researchers made the following recommendations.

The Science Teachers Association of Nigeria (STAN) and curriculum planners should organize workshops, conferences and seminars for the science teachers on the use of GDIS in teaching science and particularly chemistry.

The teacher training institutions and universities should include the GDIS in their curriculum and encourage its usage by the students.

The use of conventional method of instruction should not be allowed in teaching science, particularly chemistry.

Textbook authors should include guided discovery principles in setting some of the study questions in their science textbooks.

Science teachers should be encouraged and motivated by paying them science teachers allowance and other necessary allowances. This will spur the science teachers in using guided discovery instruction strategy in their teaching.

CONCLUSION
Based on the findings of the study, it can be seen that the use of Guided Discovery Instruction strategy in teaching chemistry is more effective and result oriented than the conventional method of instruction. The findings also indicated that both boys and girls performed equally high when taught with guided instruction strategy on interaction effect, the finding showed that both methods, guided discovery instruction strategy and the conventional method of instruction are good and effective in teaching boys and girls chemistry.

Based on the findings of the study, the researchers concluded that teachers of science and chemistry in particular should use Guided Discovery Instruction Strategy in their teaching because it leads to self-development of the students.

REFERENCES


