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Effects of Guided Discovery Teaching Strategy on Achievement and Retention in Concept Energy among Upper Basic Students in Abaji Area Council, Abuja, Nigeria

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Abstract

This study investigated the Effects of Guided Discovery Teaching Strategy on Achievement and Retention in Concept Energy Among Upper Basic Students in Abaji Area Council, Abuja. The study adopted pre-test and post-test quasi-experimental research design. The population of the study consists of all public Junior secondary school two (JSSII) during the 2023/2024 academic session in Abaji. A sample size of 95 (55 Male and 40 Female) students were selected from the target population using simple random sampling technique. The experimental group were exposed to Energy concept using Guided Discovery Teaching Strategy while the Control group were taught using Conventional Method. Two instruments, namely Basic Science Achievement Test (BSAT) and Basic Science Retention Test (BSRT) were used for data collection and had reliability coefficient of 0.82 and 0.71 obtained by the use of Kuder-Richardson 21 (K-R 21) and Cronbach Alpha (α) respectively. Four research questions were raised with four corresponding hypotheses. These hypotheses were tested using ANCOVA statistics at $P \leq 0.05$ level of significance. The findings of the study revealed that the use of GDTS Strategy in teaching energy concept to upper basic students enhanced students' achievement and retention. The study also revealed that there was no significant difference on gender-based achievement and retention. The study concluded that the application of GDTS improved students' achievement and increased retention towards Basic Science and is gender friendly. The study recommended among other that the provision of in-service training and retraining for teachers on the use of GDTS for teaching energy concepts in Basic Science.

Keywords: Guided Discovery Teaching Strategy, Achievement, Retention.

Introduction

Science and technology are one of the basic requirements for any technological development in any nation. Science and technology have become crucial factors for sustainable development worldwide. This is because Science contributes significantly to the quality of life in diverse areas such as; telecommunication, transportation, health-care, agriculture, nutrition and energy production (Akuso, 2021). The major goal of science education is to develop scientifically literate individuals that are concerned with high competence for rational thoughts and actions (Dajal & Mohammed, 2019). Science education remains a fundamental pillar for national development, as it equips learners with the creativity and skills needed to address societal and technological challenges (Egolu & Igboanugo, 2022). Basic Science is one of the foundations of science subjects in science education. It inculcates into the students the ability to manipulate things in nature. Also, help students to understand scientific problems as well as finding possible solutions to the problems. Basic science lays a foundation for specialized science study as well as increased understanding of the environment. It introduces students to logical thinking and scientific method which arouses the student's curiosity



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thereby developing scientific attitudes, improve students' achievement and retention in Basic Science concepts. Despite the importance of Basic Science as a foundation in scientific and technological development, Basic Science education has been facing the challenges of poor performance as a result of teaching strategy which teacher mostly adopt conventional teaching strategy which is teacher centred instead of Guided Discovery Teaching Strategy that is learner-centred. According to Akuso et al., (2024), the use of Activity-Based Strategy as instruction enhanced students' achievement and attitude in light waves concept. Danjuma and Mankilik (2022), revealed that Demonstration Teaching Strategy was more effective in improving students' achievement and as well as enhancing students' retention in Chemistry than the Lecture Teaching Strategy. Israel and Maake (2021), found that Guided Discovery Instructional Strategy in chemical reactions performed better than their counterpart exposed to traditional teaching method. Furthermore, Akpan et al., (2020), discovered that guided discovery teaching method had positive effect on academic achievement of the students while gender was not a significant factor in English concept. In agreement, Tukura, et al., (2020), revealed that the use of e-learning has positive effect on students' retention and performance among Upper Basic Science Students in mathematic concept.

Retention is the ability of learners to store, preserve and recall or retrieve the information learned over period of time. According to Amadi et al. (2019), found that guided discovery method had more effect on students' academic achievement and retention than lecture method. Tukura et al. (2020), revealed that the use of e-learning has positive effect on Students' Retention and Performance among Basic Science Students. In the same vein, Danjuma and Mankilik (2022), discovered a significant difference of using Demonstration Teaching Strategy and Lecture Teaching Strategy on students' retention and achievement mean scores in chemistry. Gender is one of the factors frequently cited by several researchers as the factor influencing students' achievement and retention. Nguuman et al. (2020), revealed that that gender does not determine students' fate in terms of academic achievement and retention in mathematics. Also, Akpan et al. (2020), showed that guided discovery teaching method was not a significant factor based on gender. In agreement, Israel and Maake (2021), revealed that GDIS did not discriminate against gender, suggesting that the strategy encourages girls to study science. Abari and Ikyule (2021) and Tofi et al. (2023), findings showed no significant difference in mean achievement scores of male and female students taught Mathematics and Biology using Guided discovery approach.

Objectives of the Study

The main objectives of this study was to determine the Effects of Guided Discovery Teaching Strategy on Achievement and Retention in Concept Energy Among Upper Basic Students in Abaji Area Council, Abuja. The specific objectives were to;

1. Determine the effect of Guided Discovery Teaching Strategy on the mean achievement scores of Basic Science Students taught using Guided Discovery Teaching Strategy
2. Ascertain the effect of Guided Discovery Teaching Strategy on the retention ability of Basic Science Students taught energy concepts
3. Find out the effect of Guided Discovery Teaching Strategy on the mean achievement scores of male and female students exposed to Guided Discovery Teaching Strategy Approach
4. Determine the effect of Guided Discovery Teaching Strategy on students' retention in Basic Science based on gender.

Research Questions

This study is guided by the following research questions:



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1. What is the difference between the mean academic achievement scores of students taught energy concept using Guided Discovery Teaching Strategy and those taught using conventional method?
2. What is the difference between mean retention scores of Basic Science Students taught using Guided Discovery Teaching Strategy and those taught using conventional method?
3. What is the difference between male and female students mean academic achievement scores exposed to Guided Discovery Teaching Strategy?
4. What is the difference between male and female students mean retention scores exposed to Guided Discovery Teaching Approach?

Hypotheses

The following null hypotheses were formulated and tested at $P \leq 0.05$ level of significance.

- HO₁:** There is no significant difference between teaching with Guided Discovery Teaching Strategy and Conventional Method in the mean achievement scores of students taught energy concept in Basic Science using
- HO₂:** There is no significant difference between using Guided Discovery Teaching Strategy and Conventional Method in the mean retention scores of Students in Basic Science.
- HO₃:** There is no significant difference between the mean achievement scores of male and female students exposed to Guided Discovery Teaching Strategy and Conventional method.
- HO₄:** There is no significant difference between the mean retention scores of male and female students exposed to Guided Discovery Teaching Strategy and Conventional method.

Methodology

The study adopted pre-test and post-test quasi-experimental research design. The population of the study comprised of all the Basic Science and Technology students in Public Junior Secondary Schools during the 2023/2024 academic session in Abaji Area Council of Federal Capital Territory, Abuja. A sample size of 95 (55 male and 40 female) students were selected from the target population using simple random sampling technique. The experimental group were exposed to energy concept using Guided Discovery Teaching Approach while the Control group were taught using Conventional Method. Two instruments, namely Basic Science Achievement Test (BSAT) and Basic Science Retention Test (BSRT) were used for data collection and had reliability coefficient of 0.82 and 0.71 obtained by used of Kuder-Richardson 21 (K-R 21) and Cronbach Alpha (α) respectively.

Data Collection Procedure

After permission was sought and granted by the school authorities in order to use their schools for the study. Thereafter, BSAT were served to 95 JSSII Basic Science students from the selected schools. The results were then used to ascertain relative ability in achievement in energy concepts. The Basic Science students of the intact classes of the two groups were taught using Guided Discovery Teaching Approach for the experimental group, while the Conventional teaching Method was used for the control group. The same topics were taught for six weeks in both groups (schools) using an intact class. The post-test of BSAT was administered to Basic Science students at the end of the 8th week of the study, while BSRT was administered after two weeks of treatment. The students of the two (2) groups; the experimental group and the control group took the post-test and BSRT.

Method of Data Analysis

The data collected from the study were analyzed using frequency count, mean score, and standard deviation to answer research questions, while the Analysis of Covariance (ANCOVA) statistic at $P \leq 0.05$ level of significance was used to analyze data for testing the null hypotheses. the analysis was computer-based, with the use of the Statistical Package for Social Science (SPSS-23 version).



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Presentation of Results

Research Question 1: What is the difference between the mean academic achievement scores of students taught energy concept using Guided Discovery Teaching Strategy and those taught using conventional method?

Table1: Mean and Standard Deviation in Achievement Scores of Students in Experimental and Control Group.

Groups	No. of Students	Mean Scores Pretest	S. D	Mean Scores Posttest D	Mean S. Gain
Experimental	49	15.92	1.99	36.61	20.69
Control	46	16.17	2.01	34.00	17.83
Mean Difference		0.25		2.61	2.86
Total	95				

Results on Table 1 indicates that the pretest means achievement scores of students taught basic science using guided discovery teaching strategy and those taught using conventional lecture method are 15.92 and 16.17 respectively with standard deviation of 1.99 and 2.01. Also, the post-test means achievement scores of 36.61 and 34.00 with standard deviation of 3.47 and 3.07 for both experimental and control groups were recorded respectively. The mean gain difference in achievement scores between experimental and control groups was 2.86 in favour of the experimental group.

Hypotheses 1

HO₁: There is no significant difference between teaching with Guided Discovery Teaching Strategy and Conventional Method. in the mean achievement scores of students taught energy concept in Basic Science using.

Table2: ANCOVA Results of Achievement Scores of Students Taught Basic Science Using Guided Discovery Teaching Approach and Those Taught Using Conventional Method

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	594.640 ^a	2	297.320	48.081	.000
Intercept	466.581	1	466.581	75.454	.000
Method	196.941	1	196.941	31.849	.000
Pre-test	432.736	1	432.736	69.980	.000
Error	568.897	92	6.184		
Total	119860.000	95			
Corrected Total	1163.537	94			

Table2 shows the ANCOVA result of achievement scores of students taught Basic Science using Guided Discovery Teaching Strategy and those taught using conventional method. There was significant difference in achievement to Basic Science among the groups based on methods observed $P = 0.000$ observed is less than $P = 0.05$ level of significance. Therefore, hypothesis one was rejected as it can be concluded that methods of teaching the groups had significant impacts on the achievement of students to Basic Science. This implies that the experimental groups achieved significantly higher than the control group in Basic Science energy concepts taught using Guided Discovery Teaching Strategy.

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Research Question 2: What is the difference between mean retention scores of Basic Science Students taught using Guided Discovery Teaching Strategy and those taught using conventional method?

Table 3: Mean and Standard Deviation of Retention Scores of Experimental and Control Group Students

Groups	No. of students	Mean scores		Mean scores		Mean Gain
		Pre-test	S. D	Post-test	S. D	
Experimental	49	15.92	1.99	35.43	2.79	19.51
Control	46	16.17	2.01	33.57	2.92	17.40
Mean Difference		0.25		1.86		2.11
Total	95					

Table 3 show a pre-test mean retention score 15.92 with a standard deviation of 1.99 for students taught basic science using guided discovery teaching strategy and a pre-test mean retention score of 16.17 with a standard deviation of 2.01 for students taught basic science using conventional teaching method. As for the post-test, the table also shows a post-test mean retention score of 35.43 with a standard deviation of 2.79 for students taught basic science using guided discovery teaching strategy and a mean retention score of 33.57 with a standard deviation of 2.92 for students taught basic science using conventional method. The students taught basic science using guided discovery teaching approach had a higher retention mean gain score of 19.51 compared to their counterparts that were taught basic science using conventional teaching method who had retention mean gain score of 17.40. Students taught basic science energy concept using guided discovery teaching strategy had higher retention mean in post-test, than those taught basic science using conventional method. The mean gain difference in retention scores of students between experimental and control groups was 2.11 in favour of the experimental group.

Hypotheses 2

H0₂: There is no significant difference between using Guided Discovery Teaching Strategy and Conventional Method in the mean retention scores of Students in Basic Science.

Table 4: ANCOVA Results of Retention Scores of Students Taught Basic Science Using Guided Discovery Teaching Approach and Those Taught Using Conventional Method.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	337.802 ^a	2	168.901	30.838	.000
Intercept	645.977	1	645.977	117.944	.000
Retention	101.682	1	101.682	18.565	.000
Pre-test	255.422	1	255.422	46.636	.000
Error	503.882	92	5.477		
Total	114088.000	95			
Corrected Total	841.684	94			

Significance at $P \leq 0.05$ level

Table 4 shows the ANCOVA result of retention scores of students taught Basic Science using Guided Discovery Teaching Approach and those taught using conventional method. There was significant difference in retention to basic science among the groups based on methods of $P = 0.000$ observed is less than $P = 0.05$ level of significance. Therefore, hypothesis three is rejected as it can be concluded that methods of teaching the groups have significant effect on the retention of students to Basic Science. The implication of this is that students that were taught using Guided Discovery Teaching Approach gained higher retention scores in Basic Science energy concept than those taught with Conventional Method.

Research Question 3: What is the difference between male and female students mean academic achievement scores exposed to Guided Discovery Teaching Strategy?

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Table 5: Mean and Standard Deviation in Achievement Scores of Male and Female Students in Experimental Group.

Group	No. of Students	Mean Scores		Mean Scores		Mean Gain
		Pretest	S. D	Posttest	S. D	
Male	28	15.64	1.64	36.29	3.16	20.65
Female	21	16.29	2.39	37.05	3.88	20.76
Mean Difference		0.65		0.76		0.11
Total	49					

Results on Table 5 indicated that the pre-test mean achievement scores of male and female students taught basic science with guided discovery teaching Strategy in experimental group were 15.64 and 16.29 respectively with standard deviation of 1.64 and 2.39. Also, the post-test means achievement scores of 36.29 and 37.05 with standard deviation of 3.16 and 3.88 for male and female were recorded respectively. The mean gain difference in achievement scores between male and female students in experimental group taught Basic Science energy concept with Guided Discovery Teaching Strategy was 0.11 in favour of female students.

Hypotheses 3

HO₃: There is no significant difference between the mean achievement scores of male and female students exposed to Guided Discovery Teaching Strategy and Conventional Method.

Table 6 shows the ANCOVA result of achievement scores of male and female students taught Basic

Table 6: ANCOVA Results of Achievement Scores of Male and Female Students Taught Basic Science with Guided Discovery Teaching Strategy

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	231.102 ^a	2	115.551	15.339	.000
Intercept	265.336	1	265.336	35.222	.000
Gender	.039	1	.039	.005	.943
Pre-test	224.136	1	224.136	29.753	.000
Error	346.530	46	7.533		
Total	66260.000	49			
Corrected Total	577.633	48			

Significance at $P \leq 0.05$ level

Science with Guided Discovery Teaching Strategy. There was no significant difference in mean achievement scores in basic science among the group based on gender because $P = 0.943$ observed is greater than $P = 0.05$ level of significance. Therefore, hypothesis two was retained as it can be concluded that Guided Discovery Teaching Strategy has no significant effect on gender of students. The implication of this is that the null hypothesis of no significant difference in the mean achievement scores of male and female students is retained. This means that, the difference in the mean achievement scores of male and female students in the Pre-BSAT and Post-BSAT is not statistically significant.

Research Question 4: What is the difference between male and female students mean retention scores exposed to Guided Discovery Teaching Strategy?

Groups	No. of students	Mean scores		Mean scores		Mean Gain
		Pretest	S.D	Posttest	S.D	
Male	28	15.64	1.64	35.50	3.11	19.86

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Female	21	16.29	2.39	35.33	2.39	19.04
Mean Difference		0.65		0.17		0.82
Total	49					

Table 7: Mean and Standard Deviation on retention for Male and Female Students Exposed to Guided Discovery Teaching Strategy

Table 7 shows a mean retention pre-test score of 15.64 with a standard deviation of 1.64 for male students and a mean retention pre-test score of 16.29 with a standard deviation of 2.39 for female students of experimental group taught basic science using guided discovery teaching Strategy. The post-test shows a mean retention score of 35.50 with a standard deviation of 3.11 for male students and a mean retention score of 35.33 with standard deviation of 2.39 for female students in experimental group taught basic science using guided discovery teaching Strategy. This indicate that the mean retention scores of male and female students taught basic science using guided discovery teaching Strategy is almost the same. The mean gain difference in retention scores between male and female students in experimental group taught Basic Science energy concept with Guided Discovery Teaching Strategy was 0.82 in favour of male students.

Table 8: ANCOVA Results of Retention Scores of Male and Female Students Taught Basic Science with Guided Discovery Teaching Strategy.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	116.066 ^a	2	58.033	10.270	.000
Intercept	376.701	1	376.701	66.664	.000
Gender	5.291	1	5.291	.936	.338
Pre-test	115.733	1	115.733	20.481	.000
Error	259.934	46	5.651		
Total	61880.000	49			
Corrected Total	376.000	48			

Significance at $P \leq 0.05$ level

Hypotheses 3

HO₄: There is no significant difference between the mean retention scores of male and female students exposed to Guided Discovery Teaching Strategy and Conventional method

Table 8 shows the ANCOVA result of retention scores of male and female students taught Basic Science with Guided Discovery Teaching Strategy. There was no significant difference in mean retention scores in basic science among the group based on gender $P = 0.338$ observed is greater than $P = 0.05$ level of significance. Therefore, hypothesis four is accepted as it can be concluded that Basic Science students taught using Guided Discovery has no significant effect on gender retention of students. The implication of this is that the null hypothesis of no significant difference in the mean retention scores of male and female students is accepted. This means that, the difference in the mean retention scores of male and female students in the Pre-BSRT and Post-BSRT is not statistically significant.

Discussion of Findings

The result of mean achievement scores of the experimental group in post-BSAT was higher than the post-BSAT mean achievement scores of the control group. This indicated that the use of guided discovery teaching Strategy concepts improved students' achievement in Basic Science. This higher achievement has been due to the fact that students were taught concepts in basic science using guided discovery teaching Strategy, which allowed the students to participate more effectively in the teaching and learning process. The result was further confirmed by null hypothesis that methods of teaching the groups has significant impacts on the achievement of students in basic science. Hence,



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students who were taught basic science using guided discovery teaching Strategy achieved higher than those taught using the conventional method. This positive and higher achievement may have been as a result of the active participation of the students due to the fact that the Strategy used was students-centred in nature and therefore ensured students' activity. The finding of this study is in agreement with Akuso et al., (2024), Danjuma and Mankilik (2022), Israel and Maake (2021), Akpan et al., (2020) and Tukura et al., (2020), confirmed that students exposed to Activity-based strategy, Guided discovery instructional teaching strategies and e-learning teaching strategy improve students' retention and performed better than their counterparts exposed to conventional method. The possible reason for significant difference in the mean achievement scores could be as results of experimental group were exposed to guided discovery teaching Strategy that is learner-centered learning process which allowed active participation of students.

The result on retention shows that the mean difference in retention scores between experimental and control groups is in favour of experimental group. This is further confirmed by the ANCOVA result, which indicates that the experimental group have significant impacts on the retention scores of students in basic science than the control group. These findings confirm that the use of guided discovery teaching Strategy concept enhances students' retention in basic science. The result of this study is in accordance with other studies such as Amadi, et al. (2019), Tukura et al. (2020) and Danjuma and Mankilik (2022) which confirmed that the use of appropriate instructional material such as guided discovery method, e-learning and demonstration teaching strategy enhances students' achievement, interest and retention in learning. The Strategy motivated and sustained their learning thereby evoked greater understanding and achievement in basic science. Thus, teaching and learning process was students-centered. The reason for significant difference could be as a result of experimental group were exposed to guided discovery teaching Strategy which give them better opportunity to participate actively, this help to boost their retention toward basic science.

The gender mean achievement result reveals that female students recorded higher mean achievement scores than the male students in the experimental Pre-BSAT and Post-BSAT. This mean difference was not statistically significant as revealed in the ANCOVA statistic result. This finding agrees with Akpan et al. (2020), Israel and Maake (2021), Abari and Ikyule (2021) and Tofi et al. (2023) found no significant different on gender achievement of students exposed to Guided Discovery Instructional Strategy, guided discovery Strategy and Guided Discovery method no significant difference. Also, the finding of this study is in line with Nguuma et al. (2020) revealed that there is more evidence that gender does not determine students' fate in terms of academic achievement and retention in mathematics as most innovative teaching strategies and Strategies proved not to be gender sensitive. Akuso et al. (2024) revealed that male and female students exposed to Activity-Based Strategy did not differ in their achievement. The reason for non-significant difference in the achievement of female and male students could be as results of both students were exposed to the same method which gave them equal opportunity to participate in the classroom activities. It means that the method is gender friendly; it can be used to reduce the problem of gender issues in science. The results on gender retention revealed that the mean retention scores of male students was higher than female student's taught basic science using guided discovery teaching Strategy. The result was further confirmed that guided discovery teaching Strategy has no significant impacts on gender retention of students. The finding of this study is in line with Nguuma, Itavzua and Onyia (2020) who revealed that gender does not determine students' fate in terms of academic retention in Mathematics as most innovative teaching strategies and Strategies proved not to be gender sensitive. The reason for no significant



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difference could be as a result of both male and female students were exposed to the same method which gave them equal opportunity to participate actively, this help to boost their retention irrespective of gender. Another reason for no significant difference may be attributed to the effects of basic science which is practical in nature and rooted in the constructivist principles of teaching and learning. Moreover, the ability of students to discover the relationship between basic science real world and daily life activities using guided discovery teaching Strategy, created new learning environment that exposed them to the applicability and practicability of basic science in concrete situation.

Conclusion

Based on the result obtained, the researcher draws the following conclusion:

1. The use of Guided Discovery Teaching Approach as an instructional enhanced students' achievement in energy concept better than the conventional teaching method.
2. Similarly, Guided Discovery Teaching Approach proved superior to the conventional method in promoting students' retention in energy concepts.
3. The use of Guided Discovery Teaching Approach as instructional Strategy in gender friendly in term of achievement and retention in basic science than the conventional instructional Strategy.

Recommendations

The following recommendations are made based on the findings of this research:

1. Curriculum planners in Secondary Schools should include guided discovery teaching Strategy as one of the necessary instructional materials for the teaching of basic science;
2. Government and curriculum planners should incorporate guided discovery teaching Strategy into the curricula of education faculties in universities and teacher training colleges, to ensure proper training of teachers in the new concept;
3. Government/education administrators should also organize public lectures, seminars and workshops incorporation of Science Teachers Association of Nigeria (STAN) on guided discovery teaching Strategy in schools, as a way of marketing the new concept; and
4. Basic science teachers should be encouraged to incorporate guided discovery teaching Strategy of teaching since the method provides equal opportunity for both male and female students' achievement and positive attitude in basic science concept.

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