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RELATIVE EFFECTIVENESS OF GUIDED DISCOVERY AND DEMONSTRATION TEACHING TECHNIQUES ON STUDENTS' PERFORMANCE IN CHEMISTRY IN SENIOR SECONDARY SCHOOLS IN ILE-IFE, NIGERIA

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Abstract:
The study compared the performance of students in Chemistry when taught with guided discovery and demonstration teaching techniques in senior secondary schools. It determined the effectiveness of guided discovery and demonstration teaching techniques in enhancing male and female students' performance in Chemistry. The study adopted a non-equivalent pre-test, posttest control group research design. The population for the study consisted of Chemistry students in senior secondary schools in Ile–Ife. The sample consisted of Eighty four (84) students from three schools in Ife Central Local Government Area of Osun State which were selected using simple random sampling technique. One intact class each was used. The schools were randomly assigned to three groups (Guided Discovery, Demonstration and Teacher Expository) using simple random sampling technique. Two instruments were utilized for the study. They were Chemistry Achievement Test (CAT) and Questionnaire on Attitudes of Students towards Chemistry (QASTC). Data collected were analyzed using Analysis of Covariance (ANCOVA) and Analysis of Variance (ANOVA).The results showed that, there was a significant difference in the performance of students exposed to guided discovery, demonstration teaching technique and those exposed to teacher expository teaching technique ($F= 123.972$; $p< 0.05$). The findings also showed that, there was a significant difference in the performance of male and female Chemistry students exposed to guided discovery and demonstration teaching techniques ($F= 12.04$;

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p< 0.05). This showed that male and female students performed better when exposed to guide discovery teaching techniques. The post-hoc analysis revealed that, Guided Discovery Teaching Technique (GDTT) had a better significant effect on student academic performance than Demonstration Teaching Technique (DTT) and Teacher Expository Teaching Technique (TETT). The post - hoc analysis revealed that, male and female students exposed to GDTT performed better than those exposed to DTT and that, those exposed to GDTT had the best retention ability of the concept taught. The study concluded that, guided discovery teaching technique is a better teaching technique on students' performance in Chemistry than demonstration teaching technique and the teacher expository method respectively.

Keywords: demonstration, guided discovery, teaching, techniques, chemistry achievement

1. Introduction

Chemistry is one of the science subjects which occupy a prominent place in the school Curriculum because it addresses the needs of majority through its relevance and functionality in content, practice and application (Akinbobola and Afolabi 2009). The study of Chemistry entails the learning of concepts, established principles, laws, theories and substantial laboratory work. Chemistry plays a very important role in the development of a nation, which can be seen in the economy and the standard of living of nations. In spite of the importance and utility value of Chemistry to man, it appears as if Chemistry is not being taught and presented to students in a way by which the goals of studying the subject would be achieved (Oloyede 2004).

An appraisal of the current trend in classroom practices shows that the dominant method used in teaching science and mathematics is teacher-centered which tends to emphasize rote learning rather than meaningful learning (Bamidele and Oloyede 2013).This method of teaching has failed to promote genuine chemistry understanding, students' active participation and independent works. According to Olorundare and Aderogba (2009), unless a teacher adopts suitable strategies and engage the students actively in the classroom, the students will continue to perform poorly in the sciences because students learn better, when they are actively involved in the teaching and learning processes. Irinoye, et. al (2015), to facilitate meaningful learning, students are supposed to learn for their own sake through hands –on and minds-on meta-cognitive approaches, memorization leads to regurgitation of facts, poor retention ability and non-transfer of knowledge all that served as evidence of lack of understanding thus

cannot promote self-reliance. For teaching and learning to be effective, the teacher must be skillful in the selection and utilization of appropriate teaching strategies. Teaching strategy comprises of the principles and methods used for instruction. This falls into two categories; teacher-centred approaches and student-centred approaches. Some goals are better suited to teacher-centred approaches while others clearly need student-centred approaches. Teacher-centred instruction has been criticized as ineffective and grounded in behaviourism; however, this is not the case if delivered effectively (Ogwu, 2002). Any good teaching method should have the ability to hold the students' interest and attention until the lesson is over. Knowledge of teaching methods in addition to their application results in effective teaching and learning. Chemistry teachers therefore need to be methodologically flexible if the needs, interest and aspirations of students must be met.

Research studies have also indicated that, some factors are responsible for students' poor performance in Chemistry. The most common factor identified were the inappropriate, uninspiring and non- innovative teaching methods and strategies adopted by some teachers (Akeju, 2001; Bamidele, and Oloyede 2013; Adeyemo, 2004; Adegbola, 2005; Adedeji, Oloyede, Bamidele and Bada, 2012). It was maintained that, if novel teaching methods were employed in teaching the students Chemistry, the students will perform wonderfully well. Teachers must continue to organize instruction by using learner-centered strategies that will facilitate learning. Guided discovery learning is intrinsically motivating and thus promotes the comprehension of inquiry. Guided discovery is a method of instruction through which students interact with their immediate environment by exploring, manipulating objects, wrestling with questions and controversies, or performing experiments (Akinbobola and Afolabi 2009). It is posited that, students are more likely to remember concepts they discover on their own than those they are taught. This is the constructivist based approach to education.

Guided discovery incorporates three models (Wikipedia, 2009):

I. Problem solving: This Model relates to the ways in which students expand their intellect, encountering the environment, processing the data obtained and reorganizing one's own knowledge. It uses small group activities, committee activities, individual study and investigation.
II. Learner Management: The learning must be learner-driven so that participants working alone or in small teams can learn at their own pace.
III. Integrating and Connecting: Learning must encourage the integration of new knowledge into the learner's existing knowledge and clearly connect to the real world. The role of the teacher in an integrated teaching and learning environment is to assist students with making connections and therefore finding

meaning through an educational process. This teaching strategy is certainly useful in keeping with the goals of integration to teach and learn about our world and the knowledge and skills necessary to act responsibly within and upon it.

According to Ugwuanyi (1998), discovery approach results in appropriate cognitive and affective learning simultaneously. He stated that, discovery is a success experience that reinforces the appropriate attitude and value. Umoh and Etuk (2003) define demonstration as a process whereby a person does something in the presence of others in order to show them how to do it or to illustrate a principle. Ewona (2002) opined that, demonstration is one of the best methods for teaching science as it promotes the development of skills and proficiency in performing some specific acts. For example, a science teacher may teach an idea by performing an experiment for students. Demonstration may be used to prove a fact through a combination of visual evidence and associated reasoning. Although guided discovery and demonstration techniques have been found to enhance students' performance in science, however, there is a need to examine which of these two teaching techniques will better improve students' performance in Chemistry among secondary school students. However, it is assumed that guided discovery and demonstration may be better strategies to enhance the learning outcomes of the students. Thus, the need to investigate the relative effectiveness of the two approaches. Hence, this study sets out to;

1. Compare the performance of students in Chemistry when taught with guided discovery and demonstration teaching techniques in senior secondary schools in Ile-Ife; and
2. Determine the effectiveness of guided discovery and demonstration teaching techniques in enhancing male and female students' performance in Chemistry

Two null hypothesis were tested at 0.05 level of significance

H_1: There is no significant difference in the performance of Chemistry students taught with guided discovery and those taught with demonstration teaching techniques; and

H_2: There is no significant difference in the performance of male and female Chemistry students taught with guided discovery and those taught with demonstration teaching technique.

The study is based on the constructivist learning theory. It finds its antecedents from the works and philosophies of Jerome Brunner and Vygotsky. Brunner (1966) believed that, learning is effective when learners are given the opportunity to discover facts by themselves. He thus laid emphasis on discovery learning. Brunner sees the acquisition of knowledge as an active process and thus encouraged learner's autonomy

and personal involvement in the learning process. According to Brunner, learner's independence fostered through encouraging students to discover new principles on their own accord lies at the heart of effective education. Brunner advocated for a spiral curriculum which can enable students to build upon what they have already learnt in the order of these principles.

1) Instruction must be commensurate with the experiences that make the students willing and able to learn (readiness).
2) Instruction must be structured such that it can be easily understood by the students (spiral organization).
3) Instruction should be designed to facilitate extrapolation (going beyond the information given). The implication of Brunner's theory to discovery approaches is that, teachers should create situations that would help learners to discover facts by themselves.

Vygotsky (1978), social learning constructivist offers framework for instruction based upon the study of cognition. Vygotsky's constructivism centres on allowing students to actively interact with each other. He believes that, by allowing students to actively interact with one another, there will be opportunities for investigating, experimenting and asking questions, which will lead to getting answers that will make learning real and long lasting. Vygotsky theory proffers that knowledge is situated and collaborative; therefore, knowledge is distributed among people and environment. It is important to note that constructivism is not a particular pedagogy. In fact, constructivism is a theory describing how learning happens, regardless of whether learners are using their experience to understand a lecture or following the instructions for building a model. However, constructivism is often associated with pedagogic approaches that promote active learning, or learning by doing. Bruner (1966) in his theory of learning stipulated that learning is a process in which learners construct new ideas or concepts based upon their current/ past knowledge. Brunner's constructivist theory is a general framework for instruction based upon the study of cognition. The task of the instructor is to translate information to be learned into a format appropriate to the learner's current state of understanding. The learner selects and transforms information, constructs hypotheses, and make decisions, relying on a cognitive structure to do so. Bloom (1971) described in detail one strategy for mastery learning in the classroom and suggested that teachers can develop many alternative strategies. Bloom's strategy involves the supplementation of regular instruction with frequent formative educational procedures to find out the academic level of individual students. It also involves a variety of alternative instructional materials to try to bring as many students as possible up to predetermined standard of excellence. Therefore, from the

theories discussed above, it is hoped that Chemistry students taught with demonstration and guided discovery teaching methods will develop interest in the learning process and construct their knowledge by linking it with existing knowledge to enhance meaningful learning, thereby aiding their retention ability and level. There is need to examine the relative effectiveness of the two teaching techniques so as to be sure of which one will improve learning better.

2. Method

The research adopted pretest-posttest control group design. There were three groups of students, two experimental groups and the third group was a control group. The design for the study is as represented below:

(Experimental group 1)	O_1	X_1	O_2	O_3
(Experimental group 2)	O_4	X_2	O_5	O_6
(Control group)	O_7	X_3	O_8	O_9

Where O_1, $O_4$and O_7 represent the pretest
O_2, O_5 and O_8represent the post-test, while
O_3, O_6 and O_9 represent retention ability test
X_1 = Guided Discovery Teaching Technique (GDTT),
X_2 = Demonstration Teaching Technique (DTT)
X_3 = Teacher Expository Teaching Technique (TETT)(Normal classroom Teaching)

The population for the study consisted of all Chemistry students in senior secondary schools One (SSS 1) in Ile-Ife, Ife Central Local Government area of Osun State. Three schools were selected from the Local government using simple random sampling technique. All Chemistry students in intact classes in the selected schools were involved in the study. The schools were randomly assigned to two experimental groups: guided discovery teaching technique, demonstration teaching technique and the control group: teacher expository teaching technique.

The instruments used in this study were Chemistry Achievement Test (CAT) and Questionnaire of Attitudes of Students towards Chemistry (QASTC) designed by the researcher. The questions for Chemistry Achievement Test were derived from past questions of West African Examination Council (WAEC) in Chemistry. The achievement test was divided into two sections. Section one sought for students' personal information with respect to; name, age, class and sex. The second section contained questions on the topic taught. The QASTC was designed to determine

students' attitude towards learning of Chemistry and it also consisted of two sections, A and B. Section A contained items seeking information about the personal data of the respondents while section B contained 20 items on respondents' attitude towards Chemistry. The instruments were validated through input from experts in Test and Measurement and Curriculum study Obafemi Awolowo University, Ile-Ife. Based on their comments and suggestions, the original tests were screened down from forty to thirty. The test was then administered on 30 students of senior secondary school class 1 in another school apart from experimental schools. The reliability of the instrument was determined by using the Kuder Richards on Formula 21 which is 0.63.The face and content validity of the 20 items on QASTC were determined through experts' judgment in the Department of Test and Measurement, Obafemi Awolowo University, Ile-Ife, and the researchers' supervisor. They all reviewed the items in terms of relevance, sentence structure and adequacy of the instruments. Based on their recommendations, five out of the initial 25 items were dropped. Their corrections and suggestions were made to determine which of the items were valid enough for the study and produced a final draft. The reliability of the questionnaire was determined by using Cronbach alpha. A reliability Coefficient of 0.85 was established.

The research was carried out in three different stages .The stages are the pre-test stage, the treatment stage and the post treatment stage. At the pre-test stage, the schools selected were visited by the researcher to obtain permission from the school authority and get familiar with the teachers. The researcher trained the teachers on general procedure for each teaching technique together with the researcher's instructional guides on GDTT, DTT and TETT. Before the commencement of the experiment the Chemistry Achievement Test (CAT) was administer to the student, so as to know if the students have the same basic knowledge. Also, the Questionnaire on Attitude of Student towards Chemistry (QASTC) was administered to check the student attitude before the treatment. The treatment stage, the students were exposed to the three teaching techniques; guided discovery, demonstration and teacher expository. The post treatment stage, CAT was administered to the student in other to ascertain the effect of the teaching techniques on the students. The teaching took six weeks of two periods per week. The data collected were analyzed based on the stated hypotheses using Analysis of Variance (ANOVA), Analysis of Covariance (ANCOVA) and Scheffe Post-Hoc analysis. Descriptive statistics (means, standard deviation and standard error estimates) were used to analyzed.

3. Results and Discussion

3.1 Hypothesis 1

In testing this hypothesis, the post-test scores of students exposed to Guided Discovery Teaching Technique were compared to the post-test scores of students exposed to Demonstration Teaching Technique using Analysis of Covariance statistics and the result is presented in Table 1

Table 1: ANCOVA of the performance of Chemistry students taught using guided discovery, demonstration and teacher expository teaching techniques

Dependent Variable: Post test Scores

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	2966.356[a]	3	988.785	96.908	0.000	0.782
Intercept	2322.331	1	2322.331	227.606	0.000	0.738
Pre-test Score	14.281	1	14.281	.257	0.614	0.003
Treatment	2529.856	2	1264.928	123.972	0.000	0.754
Error	826.468	81	10.203			
Total	74699.000	85				
Corrected Total	3792.824	84				

a. R Squared = .782 (Adjusted R Squared = .774)

The result showed F =123.972 and p=0.000.This implies that a significant difference existed in the performance of the students taught using Guided Discovery, Demonstration and Teacher Expository Teaching Techniques. The null hypothesis is hereby rejected. A further analysis of the comparison of the techniques was shown in Table 2

Table 2: Descriptive Analysis on Achievement of Post Test Scores

Treatment Group	N	Standard Deviation	Mean	Std. Error	95% Confidence Interval	
					Lower Bound	Upper Bound
Demonstration	29	4.510	27.745	.638	26.475	29.014
Guided Discovery	28	3.414	36.124	.614	34.902	37.345
Teacher Expository	28	3.636	22.819	.618	21.590	24.048

a. Covariates appearing in the model are evaluated at the following values: Pretest Scores of Students in the Demonstration group = 14.76.

The result here showed that, the group exposed to that guided discovery hasthe highest mean score of 36.12 followed by the group exposed to demonstration teaching

technique with mean score 27.75 and the group exposed to teacher expository teaching technique with the mean of 22.8. A post hoc analysis was run to established where the significant different lies and the result shown in Table 3.

Table 3: Scheffe post hoc test of the difference of academic achievement among the three groups

(I) Treatment Group	(J) Treatment Group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval for Difference	
					Lower Bound	Upper Bound
Demonstration	Guided Discovery	-8.379*	0.914	0.000	-10.199	-6.560
	Teacher Expository	4.925*	0.922	0.000	3.091	6.760
Guided Discovery	Demonstration	8.379*	0.914	0.000	6.560	10.199
	Teacher Expository	13.305*	0.854	0.000	11.606	15.004
Teacher Expository	Demonstration	-4.925*	0.922	0.000	-6.760	-3.091
	Guided Discovery	-13.305*	0.854	0.000	-15.004	-11.606

*. The mean difference is significant at the .05 level.

The post-hoc multiple comparison of the techniques showed that there was a significant difference in the academic performance of students exposed to the demonstration teaching technique and those exposed to the guided discovery teaching technique with a mean difference of8.38. This showed that, students exposed to guided discovery teaching technique performed significantly better than those exposed to demonstration teaching technique. There was also a difference in the performance of students exposed to demonstration and those exposed to teacher expository techniques respectively, as those exposed to the demonstration teaching technique performed significantly better (Mean I-J=4.93, $p<0.05$). There was also a difference in the performance of those students exposed to guided discovery and those exposed to teacher expository teaching technique (Mean I-J =13.305, $p<0.05$). The Scheffe post-hoc test of achievement mean scores of the three groups is shown in Table 4.

Table 4: Scheffe post-hoc test of achievement scores showing the means of the three groups

Techniques	N	Subset for alpha = 0.05		
		1	2	3
Demonstration	29	27.745		
Guided discovery	28		36.124	
Teacher Expository	28			22.819
Sig				

Means for groups in homogeneous subsets are displayed.

Table 4 revealed that, students exposed to guided discovery teaching technique had the highest academic achievement (36.124), followed by those exposed to demonstration teaching technique with the mean score of 27.745 while those with teacher expository teaching technique had the lowest academic achievement (22.819). Therefore, the guided discovery may be said to have significantly improved the academic achievement of the students in the subject when compared to demonstration and teacher expository teaching techniques respectively. This difference in the groups is represented with a pie chart (figure 1).

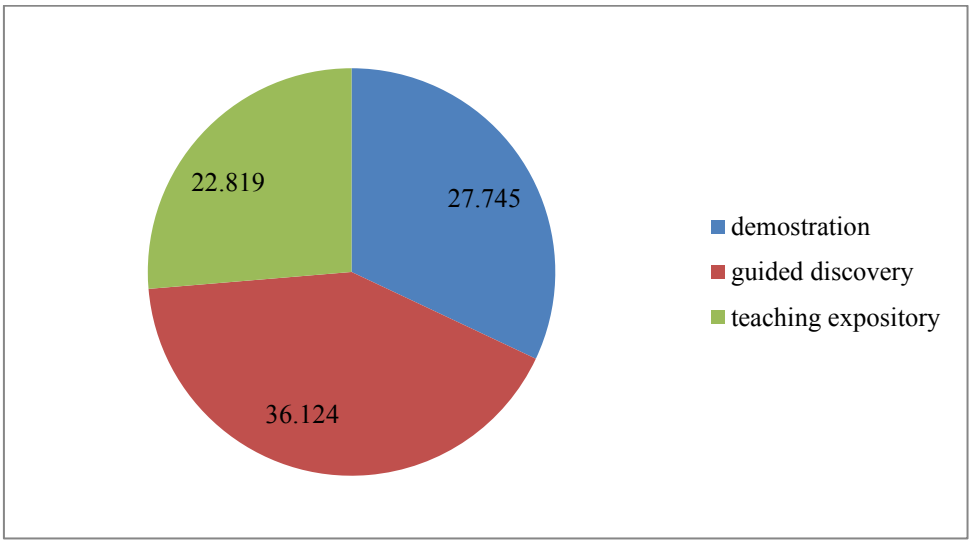


Figure 1: A Pie Chart Showing the Means scores of the Groups in Homogeneous Subsets

3.2 Hypotheses Two

There is no significant difference between the performance of male and female Chemistry students taught with guided discovery and those taught with demonstration teaching techniques. The hypothesis was test using ANCOVA; this is shown in the Table 5.

Table 5: ANOVA on the performance of male and female students taught with GDTT and those taught with DTT

Variables	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	590.614	3	196.871	12.040	.000
Within Groups	866.649	53	16.352		
Total	1457.263	56			

The analysis in Table 8 shows that, the F = 12.04 with p=0.000. This implies that, there is a significant difference in the performance of male and female students taught with demonstration teaching technique and those students taught with guided discovery teaching technique. Therefore, the null hypothesis is rejected. This revealed that gender has a significant influence on students' performance in Chemistry when taught with guided discovery and demonstration teaching techniques. A post hoc analysis was run and the result presented in Table 6.

Table 6: Scheffe post hoc test of the difference of academic achievement among male and female students exposed to guided discovery and demonstration teaching techniques

					95% Confidence Interval	
(I) group	(J) group	Mean Difference (I-J)	Std. Error	Sig.	Lower Bound	Upper Bound
Demonstration technique male	Demonstration technique female	-2.31373	1.52464	.517	-2.0886	6.7160
	Guided discovery technique male	-4.63333	1.73143	.079	-9.6327	.3661
	Guided discovery technique female	-5.00000*	1.50701	.018	-9.3514	-.6486
Demonstration technique female	Demonstration technique male	-2.31373	1.52464	.517	-6.7160	2.0886
	Guided discovery technique male	-6.94706*	1.61154	.001	-11.6003	-2.2938
	Guided discovery technique female	-7.31373*	1.36759	.000	-11.2626	-3.3649
Guided discovery technique male	Demonstration technique male	4.63333	1.73143	.079	-.3661	9.6327
	Demonstration technique female	6.94706*	1.61154	.001	2.2938	11.6003
	Guided discovery technique female	-.36667	1.59487	.997	-4.9718	4.2384
Guided discovery technique female	Demonstration technique male	5.00000*	1.50701	.018	.6486	9.3514
	Demonstration technique	7.31373*	1.36759	.000	3.3649	11.2626

	female					
	Guided discovery technique male	.36667	1.59487	.997	-4.2384	4.9718

*. The mean difference is significant at the 0.05 level.

The post hoc comparison of the techniques showed that, there was a significant difference in the academic performance of male and female students exposed to guided discovery teaching technique and those exposed to demonstration teaching technique. This showed that male and female students exposed to GDTT performed better than male and female students exposed to DTT. The effect was shown clearly in the descriptive statistic Table 7.

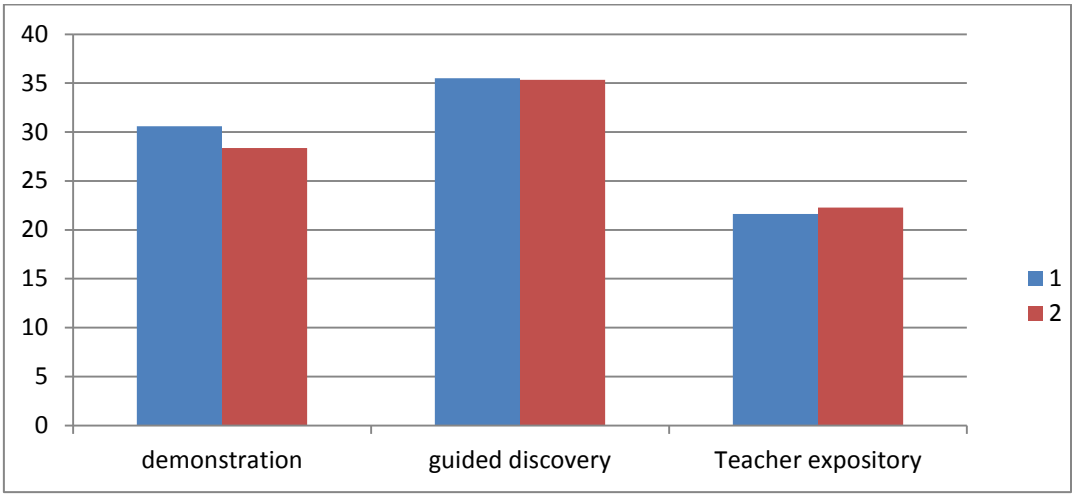
Table 7: Descriptive statistic for gender

Dependent Variable: Post test Scores

Treatment Group	**Gender of participants**	**Mean**	**Std. Deviation**	**N**
Demonstration	1	30.58	4.680	12
	2	28.35	4.429	17
	Total	29.28	4.590	29
Guided Discovery	1	35.50	3.689	10
	2	35.33	3.361	18
	Total	35.39	3.414	28
Teacher Expository	1	21.62	3.863	13
	2	22.27	3.535	15
	Total	21.96	3.636	28
Total	1	28.66	7.071	35
	2	29.04	6.531	50
	Total	28.88	6.720	85

Gender code: 1 = Male; 2 = Female

Though, the two teaching techniques are good in enhancing students' performance, but the result above showed that the male student in guided discovery (with the mean of 35.50) performed better than the male students taught with demonstration teaching techniques (with the mean 30.58). It can be deduced from the result that guided discovery enhance the performance of students with gender equality i.e. not gender bias. This was shown in figure 2.



Key: 1 = Male 2 = Female

Figure 2: Bar chart showing the performance of male and female students exposed to the teaching techniques

4. Discursion

Hypothesis showed that, there was a significant difference in the performance of students exposed to guided discovery and demonstration teaching techniques. This result is in agreement with the study Omwirhiren (2002), Ozomadu, (2004), Akinbobola A. O. and Afolabi F. (2009) in Physics, Alabi, and Lasisi, (2015) and Irinoye, et al. (2015) in Chemistry. They discovered that guided discovery was effective in enhancing student performance. They affirmed that the method is effective because it has the advantage of allowing learners to use process skills to generate content information. They maintained that the nature of guided discovery provided for activities such as: exchange of knowledge and joint construction of conclusion, interaction with peers, and feedback opportunities made it realistic to enhance the performance of learners taught with it.

5. Conclusion and recommendation

Based on the outcomes of this study, it was concluded that guided discovery is a better teaching technique in improving students' performance in Chemistry than demonstration teaching technique. More importantly, guided discovery enhanced students' academic performance because the technique is learner-centered. Also, the study concluded that guided discovery teaching technique was more effective in enhancing male and female students' performance in Chemistry than demonstration teaching technique

Based on the findings of this study, three recommendations are made:

1. Students should always be allowed to participate actively and interact freely with the teacher as this will improve their academic achievement.
2. Seminars and workshops should be organized for teachers in secondary schools on procedure and use of guided discovery teaching technique.
3. Guided discovery approach should be integrated into the curriculum of Chemistry as one of the effective teaching approaches.

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