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Effect Of Guided Discovery Method (GDM) On Interest And Achievement Of Senior Secondary School Students In Chemistry In Potiskum, Yobe State

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ABSTRACT
This study was carried out to investigate the effect of guided discovery method (GDM) on academic achievement of senior secondary school students in Chemistry. The effect of gender on the achievement of SSII students taught using G.D.M was also investigated. Four research questions and four null hypotheses were formulated to guide the study. After a review of related literature, quasi experimental design was adopted for the study. The study was carried out in Yobe South Senatorial educational zone. The population of the study was 1179 SSII students in Yobe South Senatorial education zone. The sample consisted of 142 SSII Chemistry students which were randomly selected. Questionnaire was used for data collection. Three experts validated the instruments. Kuder Richardson formula 21 methods were used to determine the internal consistency of the instruments (CAT and CII). The reliability coefficient of .86 and .76 were obtained respectively. Mean and standard deviation were used to answer the research questions and ANCOVA statistics at .05 levels of significance was used to test the research hypotheses. The major findings of the study were: G.D.M. as a method of teaching was a significant factor of students' interest and achievement in Chemistry. The group taught with G.D.M achieved higher than the group taught with lecture method. Gender was not a significant factor of the achievement of students in Chemistry. Some recommendations also were made on the use of guided discovery method of teaching.
Keywords: Gender, Guided-Discovery Method, Interest, Achievement.

INTRODUCTION
Chemistry is a scientific discipline that deals with compounds, elements, and molecules, their composition, structures, properties and the changes they undergo during reactions with other substances. Chemistry also explains how atoms and molecules interact via chemical bonds to form new chemical compounds. Chemistry is sometimes called central science because it provides a foundation for understanding basic and applied scientific disciplines. Examples of the basic and applied scientific disciplines include Botany, Geology, Ecology, Astrophysics, Pharmacology, and Forensics. Knowledge of Chemistry aids in synthesizing new substances such as cosmetics, soaps, fertilizers, insecticides,

fungicides, herbicides, fuels, lubricants, make-ups, refining and upgrading raw materials needed in other industries.

Chemistry also provides a lot of careers that include among others, cosmetics industry, brewery industry, chemical industry, textile industry, food processing and technology industry, forestry, Agricultural industry, petroleum; pharmaceutical industry, where the populace can be employed. According to Alabi & Lasisi, 2015, Chemistry is central in the drive for global sustainable economic development; Chemistry plays major roles in food (fertilizers and insecticides), clothing (textile fibers), housing (cement, concrete, steel, and bricks), Medicine (drugs), and transportation (fuel, alloy materials). Chemistry plays a significant role in the economic development of nations, which underscores the reasons for including Chemistry as one of the core science subjects offered at the senior secondary school level in Nigeria. It is a subject which basically must be studied for achieving technological development in all countries of the world.

Chemistry is one of the basic sciences that are prerequisite for technological breakthroughs, therefore, the effective teaching and learning of Chemistry in Nigeria is very crucial and demands considerable attention. The relevance and importance of Chemistry cannot be overemphasized. The knowledge of Chemistry helps boost a nation's economy. However, with the numerous importance of Chemistry, students find it quite challenging to understand the subject. The abstract nature of some concepts of the subject or perhaps the method employed by Chemistry teachers in teaching the concepts may be responsible for the students' inability to understand the concepts and that necessitated this research. There is evidence to show that the level of achievement in Chemistry is low in secondary schools.

Available literature (Ibe, 2014; Sabiru, 2014; Alabi & Lasisi, 2015 and WAEC Chief Examiner's report 2015) on the subject has revealed that students' achievements in Chemistry at SSCE have been consistently poor. The trend as indicated above of poor achievements is not different from what is obtainable in Potiskum Local Government of Yobe State.

There is no doubt from several studies that students generally have problems in grasping Chemistry concepts and therefore underachieve in examinations. Poor achievement in Chemistry is sometimes attributed to a lack of qualified teachers to handle the subject, poor teaching delivery, and teachers' method of presenting the content of the curriculum to students (WAEC Chief Examiner's Report, 2013). More importantly, many researchers (Ibe, 2014; Sabiru, 2014; Alabi & Lasisi, 2015 and WAEC Chief Examiner's report 2015) have independently attributed the blame to teachers' poor instructional methods (teacher-centered, teacher active, learner passive, content emphasis, large class size, wide content of instruction and minimal use of chalkboard and low level of interaction. These strategies are concerned with how much content is covered by the teacher before examination (Akanbi & Akinwole, 2014)), lack of organizational skills, inadequate exposure to instructional strategies, and inadequate experiences. To achieve effective teaching of Chemistry in Nigeria, emphasis has to shift from content to process which will lead to changes in instructional techniques.

These instructional techniques used in the secondary schools education for teaching Chemistry should consequently shift emphasis from the traditional chalk-and-talk; teacher-centered method to modern methods that are student-centered if effective teaching of Chemistry is to be achieved. These modern methods include an activity-based method of instruction, laboratory method, concept-mapping, inquiry method, and guided discovery approach among others (Akanbi & Akinwole, 2014). Lecture method is a one-way communication where the teacher does most of the talking and the students more often assume a passive role. The characteristics of the conventional strategy include teacher-centered, teacher active, learner passive, content emphasis, large class size, wide content of instruction minimal use of chalkboard, and low level of interaction. The lecture strategy is concerned with how much content is covered by the teacher before the examination (Akanbi & Akinwole, 2014).

Some of the methods mentioned by the experts (Akanbi & Akinwole, 2014 and Olorode and Jimoh, 2016) that promote students' achievement are demonstration, discussion, self-learning, collaborative settings, problem-solving, and guided discovery. Olorode and Jimoh (2016) asserted that the guided discovery approach is a learning situation in which the principal content of learning is not directly exposed by the

teacher but left to be discovered by the learners, making the teacher a guardian and students active participants in the learning process. Guided discovery is the teaching method that employs exploration, manipulation, and experimentation to find out new ideas, and it is a problem-solving-oriented approach. The teacher conceives a series of questions that guide the learner, step by step, making a series of innovations that lead to a single predetermined goal. Succinctly, the teacher initiates a stimulus and the learner reacts by engaging in active inquiry thereby discovering the appropriate response (Olorode and Jimoh, 2016). In the guided discovery approach, students work together in group projects and members contribute and learn from each other fostering cooperation amongst learners. This makes the learners understand and retain the content and ultimately achieve better.

One of the major contributory factors to the poor achievement of students in Chemistry is interest, which has an effect on students' achievement. Okeke (2019) opined that high interest stimulates high achievement in learning while low-interest results in poor achievement of students. Despite the importance of Chemistry, students do not show interest in the subject. Logasov (2016) thinks that subject interest contributes to motivation and increases achievement. Interest is a component of motivation that plays some prominent roles in learning and also in all dimensions of human achievement. The differences between boys and girls in relation to achievement in chemistry education have received a lot of attention in recent years.

This identity of being a boy or a girl may be referred to as gender. According to the Zell, Krizan, & Teeter, (2015), gender is a social construct that refers to the behaviors, feelings, and attitudes that a culture associates with a person's biological sex. Ajayi, (2016) referred to gender as an analytic concept that describes sociological roles, cultural responsibilities and expectations of men and women in a given society or cultural setting. Ezeh (2015) explains that 'gender describes the personality traits, attitudes, behaviour, values, relative power, influence, roles and expectation (femininity and masculinity) that society ascribes to the two sexes on a differential basis'. Omotayo (2014) explained that gender is a social connotation that has sound psychological background, and it is used to refer to specific attributes of both males and females. Males and females showed great difference in their interest and career choice. However, the issue of gender and academic performance has remained a controversial one. Therefore, gender is a psychological term and a cultural construct developed by society to differentiate between the roles, behaviour, mental and emotional attributes of males and females.

Statement of the Problem

Over the past years, the achievement of secondary school students in external chemistry examinations has been poor despite the significance of the knowledge in economic development. Many studies also indicate that the achievement of students in external chemistry examinations are consistently poor (Ibe, 2014; Sabiru, 2014; Alabi & Lasisi, 2015 and WAEC Chief Examiner's report 2015). This trend has becomes a serious issue of concern to many stakeholders in education which include governments, administrators, parents and teachers. The importance of Chemistry explain why schools, governments, students, parents, and other stakeholders in education are worried about students' poor achievement in Chemistry in the West African Senior School Certificate Examination (WASSCE) and other examination bodies. Saputra, Tania, and Rosilawati, (2023) were of the opinion that the low achievement has been attributed to the abstract nature of Chemistry and or primarily also to poor teaching methods teachers adopt in imparting the knowledge to the students which contribute to a lack of interest, motivation, and poor achievement of the learners, this study may be considered necessary to address these problems. This study will examine the impact of the guided discovery approach on the interest and achievement of senior school students II in Practical Chemistry with gender considered as an essential variable.

The guided discovery approach is an alternative instructional method that encourages students to explore concepts independently while the teacher serves as a facilitator. This approach promotes active learning, critical thinking, and problem-solving skills. The guided discovery approach involves creativity and students' participation in a well-equipped learning environment. The guided discovery approach helps students' conceptualization and understanding of the various Chemistry concepts. Despite the growing importance of Practical Chemistry in Chemistry education, there is a lack of research examining the

application and effects of the guided discovery approach on the interest and achievement of senior secondary students in Practical Chemistry.

Therefore, there is a need to investigate the effects of employing the guided discovery approach in teaching Practical Chemistry to senior secondary II students, with a particular focus on its impact on students' interest and achievement with the intention of addressing the consistent poor achievements in chemistry. Consequently, the fundamental problem of the study is located in the following broad questions: What are the pretest and posttest interest and achievement scores of SS II students in practical Chemistry in the experimental and control groups? What are the posttest interest and achievement scores of SS II students in Practical Chemistry in the experimental group based on gender? What is the interaction effect of treatment and gender on the interest and achievement of SS II students in Practical Chemistry?

Research Questions

The following research questions guided the study:

1. What are the mean achievement scores of students taught chemistry using guided discovery method and those taught using Lecture method?
2. What are the differences in the mean achievement scores of male and female students taught chemistry using guided discovery method?
3. What are the mean interest scores of students taught chemistry using guided discovery method and those taught using other conventional method?

Hypotheses

Ho1: There is no significant difference in the achievement scores of students taught chemistry using guided discovery method and those taught using lecture method.

Ho2: There is no significant difference in the mean achievement scores of male and female students taught chemistry using guided discovery method.

Ho3: There is no significant difference in mean interest scores of students taught chemistry using guided discovery method and those taught using lecture method.

Scope of the Study

It will be based on general Chemistry concepts which include analytical, organic and inorganic. These concepts are chosen because they are part of the senior school certificate examinations and students perform poorly on questions bothering on these concepts WAEC Chief Examiner's Reports (2022). The researcher intended to use Potiskum Local Government of Yobe state because it is one of the places or areas where students' have difficulty in senior secondary school Chemistry.

Guided Discovery Approach

Guided discovery learning strategy is a strategy in which the principle content of learning is not directly exposed by the teacher but left to be discovered by the learners, making the teacher a guardian and students active participants in the learning process. Olorode and Jimoh (2016) asserted that guided strategy is a learning situation in which the principal content of learning is not directly exposed by the teacher but left to be discovered by the learners, making the teacher a guardian and students active participants in the learning process. Oyewole (2017) corroborated the assertion that guided discovery teaching strategy allows the teacher to be a facilitator of the learning who should direct the student to explore the immediate environment to create or discover own solution.

The guided discovery method is a teaching technique that encourages student to take a more active role in their learning process by answering series of questions or solving problems designed to introduce a general concept (Mayer, 2013). Brunner, a cognitive psychologist was known for its development into an accepted instructional technique. The guided discovery method is based on the notion that learning takes place through classification and schema formation (Gallenestiens, 2014). Three main principles guided Brunner's development of this approach are:

1. Consideration should be given to experiences and contexts that motivate the students' interest.
2. There should be a spiral organization of the material forcing students to build previously acquired information.

3. The instruction should facilitate extrapolation- constructivist theory.

In this teaching approach, the instructor guides the student's thought process by posing a series of questions whose responses would lead to the understanding of a concept before it is explicitly stated. Children act as detectives as they solve concept attainment activities in stimulating environments (Gallenstien, 2014) in doing so, they place a newly introduced object in a category that they have previously discovered or identified. This teaching method is believed to increase retention of material because the student organizes the new information that has already been stored.

Guided discovery method places the teacher as the overseer and facilitator of learning, and as the mediator between the students and the instructional materials for the lesson. The method is said to have the capacity to promote critical thinking and objective reasoning. In guided discovery learning, learners must be guided along a path toward discovery of ideas, concepts and information. Olorode & Jimoh (2016), asserted that this requires two things: 1. A learning design that builds ever-increasing understanding and comprehension in learners without causing frustration or apathy. Challenging yet achievable activities allow learners to stretch their thinking and be successful and 2. A learning facilitator who is a guide rather than a teacher during the learning activities. Facilitators provide initial guidance, monitor progress, steer learners back on track if necessary, ask questions to ensure understanding facilitate feedback when required given positive reinforcement and help learners integrate concept into the learner's own job responsibility.

In summary, relevant literature to the study as it relates to guided discovery approach and its effect on students' academic achievement was reviewed and presented. Under the theoretical framework cognitive theories based on the works of Jerome Bruner and constructive developmental theory of knowledge acquisition were discussed. The two cognitive theories seemed most relevant in explaining Guided-discovery approach and its relevance to teaching and learning and its effect on academic achievement. Interest Theory based on John Dewey philosophy and others were also discussed and that if the teachers may employ methods that will arouse interest of the students in the subjects the teachers are teaching, students' achievement may be improved.

The empirical studies that are found relevant to the study were reviewed and highlighted. The review of the available and relevant literature demonstrates that Guided-discovery approach of teaching resulted in higher students' achievement and other social skills compared to other teaching methods, therefore Guided-discovery approach of teaching can be used for instructional purposes in any subject such as Chemistry. However, there are some potential gaps that can be identified: Generally, these gaps include limited generalizability, pre-existing differences between groups, lack of long-term assessment, limited assessment tools, possible confounding factors, lack of comparison with alternative approaches, narrow focus, small sample size, and limited detail on the 5E learning model integration, lack of information on ethical considerations, effect sizes, limitations of the study, lack of context, limitations in research design, insufficient sampling and generalizability information, incomplete intervention details, limited assessment of interest, incomplete data analysis description, absence of a comprehensive discussion of results and implications. Future research with a more robust design and larger, more diverse samples is recommended to validate and generalize the findings.

Generally, the reviewed literature is replete with quasi experimental studies however, the literature shows that previous related studies in Nigeria are not recent and are mostly in other areas of subjects. Findings in these subject areas may not present a clear picture of the outcomes in Chemistry Education where a high level operational skill is required. Therefore, a gap which calls for research in application of the psychological processes, teaching strategies and knowledge structures appropriate for the desired learning outcomes to be achieved in senior secondary school Chemistry exists. It is expected that Guided-discovery approach of teaching may provide foundation for optimizing the learning outcomes.

Reviewed also are empirical studies on interest, as a variable in students' achievement and a variable in learning Chemistry. The review of the available and relevant literatures on the factors and variables indicated that there are conflicting, inconsistent and inconclusive reports on their influence on students' academic achievement in various school subjects like Chemistry. It is hoped therefore, that the present

study will solve the problem of the above issues by finding out if interest and achievement of students' in practical Chemistry can be positively influenced, if students are taught using Guided-discovery Strategy of teaching in relation to the traditional lecture method.

METHODOLOGY

The design of study was quasi experimental design. Specifically, the nonequivalent, non-randomized control group, pretest, post-test was adopted. The quasi – experimental design was used since the class of students that was used were already been organized into intact classes to provide for stability and avoid disruption of class lessons and class arrangement. The subjects were not randomly assigned rather intact classes of experimental and control groups were used and were given pre-test and post-test. The sample for the study consists of 142 SSII students, 72 students served as the experimental group and 70 students served as the control group. Two classes that were one male and one female were the experimental and two classes one male and one female served as the control group were purposefully selected.

Two instruments; Chemistry Interest Inventory Scale (CIIS) and Chemistry Achievement Test (CAT) were developed by the researcher for data collection. The Chemistry Achievement Test consists of 50 multiple choice objective test items and three essay type questions based on secondary school curriculum content for SS two Chemistry.

The other instrument, Chemistry Interest Inventory Scale (CIIS) consists of 40 items and a set of four scaled response options to assess students' interest in Chemistry. A four-point Likert type of interest rating scale were used to enable students indicate their level of interest for positive statement and for negative statement were as follows; SA = strongly agree, A = agree, D=disagree, SD = strongly disagree. Both the CAT and CIIS were used for pretest and posttest treatments respectively. The instrument CAT was subjected to face and content validation to make sure that the instrument measured what it intended to measure by an expert. The contents validation of CAT was achieved by the use of table of specification, purpose of the study, research questions, hypotheses, lesson plans along with CAT items were validated by the expert. CIIS items were presented to the expert to examine the extent to which the statement in CIIS assessed interest in Chemistry. The reliability of the instruments, Chemistry Achievement Test (CAT) and Chemistry Interest Inventory Scale (CIIS) were established through trial testing of the instruments on group of 72 SS two students from schools which were not within the study area. The scores generated from trial testing were used to determine the reliability of the two instruments. The reliability of Chemistry Achievement Test was established to determine the consistency of the instrument, internal consistency estimated was used to establish the reliability of CAT. The scores got were used to estimate the reliability coefficient using Kuder Richardson formula 21 (K-R21) and the coefficient of the reliability was 0.86. The internal consistency coefficient of Chemistry Interest Inventory Scale (CIIS) was established using the scores generated from pretest and posttest for CIIS. The scores generated from the instrument were applied to the Cronbach's modified Kuder Richardson formula (Cronbach alpha) to obtain the reliability coefficient of 0.76. This implies that the instruments were reliable to that extent. The researcher trained the research assistants (4 chemistry teachers, 2 in each school) in order for them to acquire competence for implementing the experimental conditions. The research assistants were trained using the following Chemistry concepts; 1. Concepts of volumetric analysis and that of qualitative analysis. 2. Concepts of acid and base titrations. 3. Calculation of concentration of acid or base. 4. Identification of anions and cations

At the end of the 4 weeks training session, the researcher and the research assistants had an extensive discussion which helped the researcher to evaluate their competencies. The pre-test was administered on the participating students of the experimental and control groups with the help of the research assistants. After the pre-test, the trained teachers started the actual treatment in their schools. Treatment group was taught each topic using Guided Discovery Method while control group was taught using Lecture method. At the end of the four week, the CAT and CIIS were administered on all the participants as posttest. The data collected and collated were used for analysis to address the research questions and hypotheses developed for the study.

DATA ANALYSIS AND RESULTS

The four research questions were answered, using mean and standard deviation of the experimental and control group scores. The four hypotheses were tested at.05 level of significance using analysis of covariance (ANCOVA) with the pre-test serving as covariates. ANCOVA was preferred because of its power to take care of the initial lack of equivalence in the groups since intact classes were used for the study.

Research Question One: *What are the mean achievement scores of students taught chemistry using guided discovery method and those taught using Lecture method?*

Table 1: Students' pre/post achievement mean (X) scores and standard deviation (SD) in chemistry for both experimental and control groups.

Group		Pre-test score		Post-test score		
	N	X	SD	X	SD	Mean gain score
G.D.M	62	36.27	14.57	65.29	14.74	29.02
L.M	62	35.33	13.10	43.89	12.75	8.56

Table 1 shows that for the pretest achievement, the mean scores of those taught with G.D.M (experimental group) is 36.27 with standard deviation of 14.57 while the posttest achievement mean score` is 65.29 with standard deviation of 14.74. For those taught with Lecture method (control group), the mean achievement score for pretest is 35.33 with standard deviation of 13.10 and posttest mean score of 43.89 with standard deviation of 12.75. Therefore, there is a mean gain of 29.02 for the experimental group and 8.56 in the control group. This shows that the experimental group achieved higher than the control group. Therefore the Null Hypothesis is rejected which means that method is a significant factor of students' achievement in chemistry.

Research Question Two: *What are the differences in the mean achievement scores of male and female students taught chemistry using guided discovery method?*

Table 2: Male and female students' pretest/posttest achievement mean scores and standard deviation for the experimental groups.

Sex		Pre-test score		Post-test score		
	N	X	SD	X	SD	Mean gain score
Male	30	36.68	15.28	66.73	14.50	30.05
Female	32	36.18	14.81	62.75	14.22	26.57

The Table 2 indicates that pretest and posttest achievement mean scores of male students in the experimental setting are 36.68 and 66.73 with standard deviation of 15.28 and 14.50 respectively as against pre and post achievement mean scores of 36.18 and 62.75 with standard deviation of 14.81 and 14.22 for female students setting respectively. Therefore, the male students achieved higher with the mean score of 3.48 than female counter parts in the CAT using G.D.M. Therefore, the null hypothesis is accepted. This means that gender is not a significant factor on students' achievement in chemistry when taught with G.D.M.

Research Question Three: *What are the mean interest scores of students taught chemistry using guided discovery method and those taught using other conventional method?*

Ho 3: There is no significant difference in mean interest scores of students taught chemistry using guided discovery method and those taught using other conventional method?

Table 3: Students' pretest/posttest interest mean scores and standard deviation in chemistry for both experimental and control groups.

Group		Pre-test score		Post-test score		
	N	X	SD	X	SD	Mean gain score
G.D.M	62	46.84	6.18	64.27	10.85	17.43
L.M	62	45.07	5.86	49.52	6.62	4.45

From Table 3, it shows that the pretest interest mean scores and standard deviation for those taught with G.D.M (experimental group) and standard deviation for the experimental groups are 46.84 and 6.18 respectively while their posttest interest mean scores and standard deviations are 64.27 and 10.85 respectively. For those taught with Lecture method (control group), the pretest interest mean scores and standard deviation are 45.07 and 5.86 respectively while that of posttest interest mean scores and standard deviation are 49.52 and 6.62 respectively. It can then be deduced that the experimental group achieved higher than the control group in both pretest and posttest interest test (CIIS). In other words, there is a higher mean gain of (17.43) in the posttest interest scores of experimental group than that of control group.

Ho 1: There is no significant difference in the achievement scores of students taught chemistry using guided discovery method and those taught using Lecture method.

Table 4: Analysis of Covariance (ANCOVA) of students' posttest interest means scores in CIIS.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Decision
Corrected Model	12358.547	4	2115.080	30.762	.000	
Intercept	1522.150	1	1522.150	23.148	.000	
Posttest	2293.689	1	2293.689	34.881	.000	
Method	393.301	1	393.301	5.978	.015	S
Gender	2.728	1	2.728	.041	.839	NS
Error	8219.607	120	65.757			
Total	512383.000	124				
Corrected Total	20356.629	123				

R Squared = 596 (Adjusted R Squared = .577)

Table 4 reveals that the computed mean value for the effect of method (G.D.M.) on interest of students' in physics is F value of 5.978. This value is significant at .015. The decision is that null hypothesis is rejected. Thus implies that interest is a significant factor on students' achievement in chemistry.

CONCLUSION

Based on the findings of this study the following conclusions are made:

a. G.D.M. had a significant effect on both the Achievement and Interest of students' chemistry. This means that the G.D.M made students to put in more interest thereby achieving higher than those taught with Lecture method

b. Gender or age had no significant effect on the achievement. This means that both male and female students regardless of age achieved to an extent with the G.D.M but there was a slight difference in favour of male but it was insignificant. The researcher also discovered that the interest level of male and female students taught with G.D.M. increased evenly.

RECOMMENDATIONS

Based on findings of this study, the following recommendations are raised:

1. Guided discovery approach should be integrated into the curriculum of chemistry as one of the effective teaching approaches for use. Chemistry teachers should always adopt guided discovery

approach for teaching their learners, this will enable the students to cater for themselves in their classrooms and thus, enhance their learning outcomes.

2. The policy makers and curriculum planners should not only elucidate those effective teaching methods or approaches to be used, but they should monitor their implementation as well
3. Workshops, seminars and training/retraining should be planned/structured by ministries of education and related government agencies on how to make use of G.D.M. for teaching science subjects especially physics efficiently.

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