IMPACT OF GUIDED-DISCOVERY METHOD ON INTEREST AND ACADEMIC ACHIEVEMENT OF SENIOR SCHOOL STUDENTS IN PHYSICS IN ILORIN, NIGERIA

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Abstract

The study comprised of 240 students, experiments 124 students and 12 physics teachers selected by multistage random sample from twelve senior secondary schools in Ilorin, Nigeria. This study was carried out to examine the impact of guided discovery method (G.D.M) on interest and academic achievement of senior school students in physics (the backbone of technology). The influence of age, location and gender on the interest and achievement of SS One students taught using G.D.M was also examined. Four research questions and null hypotheses were generated and formulated to guide the study. Quasi experimental design using questionnaire technique was adopted. Kuder Richardson formula 21 was used to determine internal consistency of the instruments (PAT and PIIS). The reliability coefficient of .79 and .64 were obtained. The mean score was used to answer research questions and hypotheses tested using ANCOVA statistics at .05 level of significance. When physics were taught using G.D.M, gender or age was not a significant factor of students' overall achievement, but this method has a significant impact on students' interest in physics. Recommendations were suggested that 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 among others.

***Keywords**: Gender, Location, Guided-Discovery Method, Interest, Achievement*

Introduction

The advances and breakthroughs of 20th-century physics have enriched all the sciences and opened a new era of discovery, Canţer, (2005). The pace of discovery in physics has quickened over the past two decades Aydoğdu, (2018), Kennedy, (2016). Physics at the tiniest distances is being linked to the origin and fate of the universe itself, Cuhls, Blind& Grupp, (2012).

With physics now connected strongly to the other sciences and contributing to many national needs, education in physics is of vital importance. Physics is at the heart of the technology driving our economy, and broad scientific literacy must be a primary goal of physics education at all levels Graham, (2018). To achieve this goal, to provide an education linked to the wider world that is so important for learners, and to draw more students into careers in science will require the best efforts from the grass root of learning physics, National Research Council (1989), Tobias, (1992) Roth& Roychoudhury (1993).

The problems that physics can address are global problems, and physics itself is becoming a more international enterprise Hazari, Sonnert, Sadler & Shanahan, (2010)Petroski (2011).

Secondary education is a principal part of an educational system in Nigeria as a developing country because it is aimed to provide capability, skill, aptitude, proficiency or technology know-how among others for constructive living to those whose education is ended at this level (Nkechi, Emeh-Ikechukwu & Okechukwu, (2012), FRN, 2004). Its broad aims and objectives arepreparation for useful living in the society and preparation for higher education, Uwaifo & Uddin (2009) Godwin, (2009).

To achieve these, the secondary school curriculum is structured to include physics for science students at senior level among other subjects taught in secondary schools in Nigeria, Daramola & Omosewo (2012), Adeyemo (2010). The level of achievement in the subject by students is not encouraging Nnaka & Anaekwe (2006). Factors that hinder this achievement may include these; teaching methods, age of the learner, students' lack of interest, school locations, gender issues etc. (Wolf& Fraser, (2008), Owoeye& Olatunde-Yara,(2011))

Physics as a backbone of technology and without technology, there is no meaningful development required students interest to boast our society. Lent, Brown& Hackett, (1994) and Eze, (2002) viewed Interest as emotionally oriented behaviour trait which determines a student's vigor in tackling educational programme or other activities. It is an essential variable in learning because it enhances teaching-learning process and the learner is able to retain facts, otherwise, inhibits learning and retention according to Bender, (2012).Côté & Levine (2000) pointed out that interest must be supported by proven ability, aptitude and attitude.

In Kampete, (2015) opinion, gender is a cultural construct developed by the society to distinguish the roles, behaviours, mental and emotional characteristics of males and females. In showing the difference between sex and gender, Epstein (1988) and American Psychological Association. (2015)states that sex is a physical distinction while gender is a social and cultural one, thus deduce that responsibilities and opportunity or prospect of males and females are defined by societies and cultures, that is, men and women have certain way to behave and perform duties. It can also be viewed that males and females adapt differently to different teaching methods, strategies and approaches, Gurian, (2010), therefore, gender refers to the varied socially and culturally constructed roles, qualities, behaviour and so on that are ascribed to women and men of different societies, Lorber & Farrell (Eds.). (1991) and Robinson, (2020).

Apart from gender, location of the school and age of learner are also variables that play an important role in learning. LeSage & Charles (2008) refer location as urban and rural areas. Secondary schools in Nigeria are located in urban and rural areas. Age is the length of time that a person has lived or a thing has existed; also a distinct period of history, online dictionary; Jaspers, (2014). Over the years there has been a controversy on the question of whether schools have effect on the behaviour and attainment of children who attend them and also age determines the ability and capabilities of the learner. The location of a school determines so many things that are important in learning such as learning facilities and environmental factors, infrastructures, number and quality of teachers and the class size, to

mention but a few (Obioma, 2004 and Akubue, 2007). If all these are provided adequately, there is tendency in improvement of learning by students. School is a place where formal education is taken place, so, it playsan importance role in the intellectual development of learners that pass through it. The location of a school is where the school is situated and this determines the classroom environment of which is an essential tool in teaching and learning process, the nature of classroom environment plays a vital role in enhancing learning, encouraging effective social relationships, especially in developing tolerance and determining role behavior (Okeke, 2000, Obioma, 2004 and Akubue, 2007). The difference in school environment is expected to result to a differential impact in the knowledge of the subject. A good learning environment has the following advantages of fostering desirable behaviour and attitude, developing problem solving skills and thought encouraging students' interrelationships and when well-planned and properly arranged can be effective in accommodating learner centered methods like guided discovering method etc., Ozioko (2015), Hofstein & Lunetta (1982), Saavedra & Opfer (2012). Unfortunately, schools in the rural areas cannot boast of classroom environment so students in this area are disadvantaged due to poor staffing, lack of laboratory facilities and other educational materials (Okeke 2000).

Various studies reviewed that many variables have been responsible for students learning outcomes in Physics, but teaching methods is the most upsetting as it has great effect on the students' academic achievement (Almaz 2019) (Arriassecq, I., & Guridi, V. (2020)). Somearchaic teaching methods usedcan hinder students' interest, poor achievement, poor retention of learning materials and promote unconstructive attitude toward the subject therefore teachers are implored to use methods that engage students' participation and interest so that they cannot be held responsible for the above mention traits (Kikkert1983 and Villarreal2008)

Guided Discovery Method is a powerful instructional approach that guide and motivate learners to explore information and concepts in order to construct new ideas, identify new relationships and create new models of thinking and behaviour, Adams & Freeman (2016); O'Neil& Pegrum (2018). Guided Discovery Method is a method that encourages learners to explore the content through the use of concrete experience, Uwameiyi and Ogunbemeru (2005). Therefore, guided discovery method is a method that is characterized by convergent thinking and the method also enables students to make references with limited guidance from the teacher with the opportunity to discover principles or explanations Nguyen (2018) (Spence, Jensen and Shepherd 2004).

In view of the above, the archaic and ineffective method which is devoid of the teacher and his authority, his domineering functions and activity in the teaching process should be de-emphasized based on its characteristics of being leader centered, leader active, students passive and content emphasis (Cantrell, (2004), Uwameiye and Ogunbemeru, (2005)). One good way of carrying out a change in methods of teaching a subject is to discover through experimentation and empirical evidence that such methods can yield effective instructional outcomes, Mee, Sui, Jano, & Husin, (2016), Bower (2000) like this case of study.

Statement of the Problem

It has been observed that abstract nature of studied physics contributed to the lack of interest, motivation and poor performance of the learners (Tsagkatakis, Aidini, Fotiadou,

Giannopoulos, Pentari & Tsakalides 2019) and to break the barriers, this study consider necessary. The study examined the impact of guided discovery method on academic achievement and interest of senior school students in physics with location, age and gender consider as essential variables that contribute to students' achievement and interest in Physics.

Purpose of the Study

The purpose of this study was to find out the impact of guided discovery method on interest and academic achievement of Senior School Students in Physics in Ilorin, Nigeria.

Research Questions

The following research questions guided the study:

i. What are the mean achievement scores of students taught physics using guided discovery method and those taught using other conventional method?

ii. What are the differences in the mean achievement scores of male and female students taught physics using guided discovery method?

iii. What are the mean interest scores of students taught physics using guided discovery method and those taught using other conventional method?

iv. What are the differences in the mean achievement scores of urban and rural students taught physics using guided discovery method?

Research Hypotheses

To answer the research questions four hypotheses has been formulated to act as a guide:

Ho_1: There is no significant difference in the achievement scores of students taught physics using guided discovery method and those taught using other conventional method?

Ho_2: There is no significant difference in the mean achievement scores of male and female students taught physics using guided discovery method?

Ho_3: There is no significant difference in mean interest scores of students taught physics using guided discovery method and those taught using other conventional method?

Ho_4: There is no significant difference in the mean achievement scores of urban and rural students taught physics using guided discovery method?

Methodology

The design of study was quasi experimental design. Specifically, the nonequivalent, non-randomized control group, pretest, post-test design 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 240 (SS One) students, 124 students from twelve senior secondary schools in Ilorin, Nigeria were experiments. Multistage sampling technique was adopted for this study. The use of balloting was employed to draw the two female senior secondary schools, two male secondary schools and eight mixed senior

secondary schools from urban and rural area accordingly, to sampled out based on gender and location, then the classes were purposively sampling, simple random sampling technique involving the use of 'yes' and 'no' was used to assign the secondary schools into experimental group and control group. Every member of the SS One stream was used for study so as give room for stability and also helps to avoid disruption of class lessons and class arrangements; however, this stage was base on non-randomization of students/subjects into treatment and control groups.

Two instruments; Physics Interest Inventory Scale (PIIS) and Physics Achievement Test (PAT) were developed by the researcher for data collection. The Physics Achievement Test consists of 40 multiple choice objective test items based on secondary school curriculum content for SS One Physics. She developed a table of specification used in generating the PAT items. Forty (40) questions were drawn from Concepts of Matter, Fundamental and derived quantities and units, Motion and Motion under gravity, Work, Power and Energy, Heat energy and Heat transfer, Current Electricity, Simple Harmonic Motion and Speed and Velocity. There were 15 questions on knowledge level, 10 questions on comprehension, 10 question on application and 5 questions on analysis, bringing the total to 40 questions. The basic consideration in developing the table of specification was that objectives be achieved by each topic as stipulated in the curriculum. The other instrument, Physics Interest Inventory Scale (PIIS) consists of 40 items and a set of four scaled response options to assess students' interest in Physics. 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 PAT and PIIS were used for pretest and post-test treatments respectively.

The instrument PAT 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 PAT was achieved by the use of table of specification, purpose of the study, research questions, hypotheses, lesson plans along with PAT items were validated by the expert. PIIS items were presented to the expert to examine the extent to which the statement in PIIS assessed interest in physics.

The reliability of the instruments, Physics Achievement Test (PAT) and Physics Interest Inventory Scale (PIIS) were established through trial testing of the instruments on group of 24 SS one 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 Physics Achievement Test was established to determine the consistency of the instrument, internal consistency estimated was used to establish the reliability of PAT. The scores got were used to estimate the reliability coefficient using Kuder Richardson formula 21 ($K\text{-}R_{21}$) and the coefficient of the reliability was 79. The internal consistency coefficient of Physics Interest Inventory Scale (PIIS) was established using the scores generated from pretest and posttest for PIIS. The scores generated from the instrument were applied to the Cronbach's modified Kuder Richardson formula (Cronbach alpha) to obtain the reliability coefficient of .64. This implies that the instruments were reliable to that extent.

The researcher trained the research assistants (12 physics teachers in each school) in order for them to acquired competence for implementing the experimental conditions. The contents of the training were;

a. Familiarization with the content, achievement, objectives and activities of students in learning the units of instruction which include:
- Concepts of matter
- Fundamental and derived quantities
- Motion and motion under gravity
- Work, Power and Energy
- Heat Energy and Heat Transfer
- Current Electricity
- Simple Harmonic Motion
- Speed and Velocity

b. Review of the lesson plans prepared by the researcher to guide the assistants during experimenting.

c. Administration of the two instruments (PAT and PIIS).

Thus, Steps of Guided Discovery Learning are; Exploration: Teacher presents divergent questions and assesses the students by providing them environment for discovery, Invention: In this stage, with the help of the teacher, the students, find the meaning and structure ideas and Discovery: The child applied what he learned in exploration and invention stages to new situations.

At the end of the training session, the researcher and the teachers had a 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 trained teachers who were 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 other convention method. At the end of the eight week, the PAT and PIIS 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.

The details of the units were found in the lesson plans for the treatment and control conditions.

Control of Extraneous Variables

The Control of Extraneous Variables in this study was achieved through the following procedure:

Training of the Research Assistants

One Week Training Programme was organized for the Physics teachers in the sampled schools to assist in the study. The teachers were educated on the necessary techniques required for teaching students through Guided Discovery Method and one of the conventional methods for the experimental and control groups respectively.

Teacher Variable
The problem of teacher variables arises when different teachers are involved in an experiment since different teachers; possess different qualities in terms of knowledge of the content, methodology and qualification. In other to control this variable in the present study, the researcher prepared lesson plans covering the topics of the study. The lesson notes and procedures for assessing each group were extensively discussed with the teachers. Using the lesson notes, each teacher taught the group of students, adopting required assessments techniques which were supervised by the researcher. Different lesson plans for experimental and control group were used.

Experimental Bias:
To avoid experimental bias, the students were taught by their regular Physics teachers in their various schools. The researcher was not involved in the administration of the research conditions.

Inter-Group Participant Variables
This refers to the differences among the study groups or participant with respect to level of intelligence. Since intact classes were used and intelligence was not measured, this was bound to introduce error variance in the students' achievement. Analysis of covariance (ANCOVA) was used to partial out the initial differences of the research subjects.

Class Interaction
To minimize continuation due to class interaction, the students were not informed about the study to reduce curiosity that would bring about exchange of ideas, outside the class room. Furthermore, to reduce suspicion that something was going on, the Physics Achievement Test instructional strategy took place within the class lesson periods when the students in the control group engaged in their class work and so they did not witness the activity or demonstration

Hawthorne Effect
Hawthorne effect is created when the study subject become aware that their achievements are being studied and therefore become conscious of the study. To reduce this effect, the treatment and control groups were taught during their normal Physics lesson periods, and by their usual physics teachers.

School Variable
School variable may introduce some errors in the validity of the study with respect to school provision. This variable to be controlled by ensuring that each four schools used for study were identical in terms of tradition, facilities and equipment.

Pre-test Sensitization
Since the same instruments were used for the study as pre and post tests, students could become familiar with the test instrument thereby introducing error into the study. To minimize this effect, all the instruments were collected after pre-testing by the researcher and kept until the day of the pos-testing. The pos-test items were restructured to reduce any effect of the pre-test.

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 physics using guided discovery method and those taught using other conventional method?

Ho 1: There is no significant difference in the achievement scores of students taught physics using guided discovery method and those taught using other conventional method

Table 1: Students' pre/post achievement mean (X) scores and standard deviation(SD) in physics 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
Conventional (Discussion)	62	35.33	13.10	43.89	12.75	8.56

Table1 shows that for the pre achievement test, the mean scores of those taught with G.D.M (experimental group) is 36.27 with standard deviation of 14.57 while the post achievement test means score` is 65.29 with standard deviation of 14.74. For those taught with Conventional (discussion) method (control group), the mean achievement score for pre-test is 35.33 with standard deviation of 13.10 and post-tests 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 physics**.**

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

Ho 2: There is no significant difference in the mean achievement scores of male and female students taught physics using guided discovery method?

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

Sex		**Pretest scores**		**Post test score**			
	N	**X**	**SD**	**X**	**SD**	**Mean score**	**gain**
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 2indicates that pre and post 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 PAT using G.D.M. Therefore, the null hypothesis is accepted. This means that gender is not a significant factor on students' achievement in physics when taught with G.D.M.

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

Table 3: Students' pre/post interest mean scores and standard deviation in physics for both experimental and control groups.

Group		**Pretest scores**		**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
Discussion	62	45.07	5.86	49.52	6.62	4.45

From Table 3, it shows that the pre-interest test 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 post interest test mean scores and standard deviations are 64.27 and 10.85 respectively. For those taught with discussion method (control groups), the pre-interest test mean scores and standard deviation are 45.07 and 5.86respectively while that of post–interest test mean scores and standard deviation are 499.52 and 6.62 respectively. It can then be deduced that the experimental groups achieved higher than the control groups in both pre and post interest test (PIIS). In other words, there is a higher mean gain of (17.43) in the post-interest scores of experimental groups than that of control groups.

Table 4: Analysis of Covariance (ANCOVA) of students' post-interest mean scores in PIIS

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	
Pretest	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
Location	31.331	1	31.331	.476	.491	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 physics.

Research Question Four: What are the differences in the mean achievement scores of urban and rural students taught physics using guided discovery method?

Ho_4: There is no significant difference among the mean interest scores of age, urban and rural students taught physics using GDM?

Table 5: Urban and Rural student's pre and post achievement mean scores and standard deviation for experimental group

		Pretest scores		**Post test score**		
Location	**N**	**X**	**SD**	**X**	**SD**	**Mean gain score**
Urban	34	41.60	17.31	75.00	16.29	33.40
Rural	28	31.66	12.96	54.97	12.81	23.31

Table 5 indicates that pre and post achievement mean scores of urban students in the experimental setting are 41.60 and 75.00 with standard deviation of 17.31 and 16.29 respectively as against pre and post achievement mean score of 31.66 and 54.97 with standard deviation of 12.96 and 12.81 for rural students respectively. Therefore, the urban students achieved higher with the mean score of 10.09 than rural matching parts in the PAT using G.D.M.

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' physics. This means that the G.D.M made students to put in more interest thereby achieving higher than those taught with other conventional 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.

c. On the issue of Location, urban students achieved higher than rural counterpart in physics when taught with G.D.M while urban and rural students taught with G.D.M. level of interest increased evenly. This implies that location had impact on students' achievement but had no influence on students' interest in physics.

Therefore, the advantages of guided discovery methods include; It helps the students to become more autonomous, self-directed and responsible for their own learning, It enhances

the development of intellectual capacities and problem solving, It enhances motivation, interest and satisfaction, It minimizes verbal learning and Give more time to the student to assimilate and accurate information. Though, it has little disadvantages such as; More time for the lesson, Difficulties to slow learners, and Expected benefit do not sign up in regular achievement test

Recommendations

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

1. Guided discovery approach should be integrated into the curriculum of physics as one of the effective teaching approaches for use. Physics 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.
4. Students should always be encouraged to participate actively and interact freely with the teachers as this will improve their academic achievement gain in their subjects. Also, both male and female students benefited evenly when taught physics using G.D.M., therefore, they should be encouraged to pursue most of the physics based courses such engineering courses (mechanical, electrical, civil, agricultural, computer etc.), medical courses virtually all science and technology courses since most of the abstract concepts can now be explain using G.D.M. It makes such concepts to be tangible, real and easily conceptualized.

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