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# Guided Inquiry and Demonstration Approaches on Students' Achievement on the Concept of Equilibrium of Forces in Ikot Ekpene Local Government Area, Akwa Ibom State

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## Abstract

This study examines the effect of guided inquiry and demonstration approaches on Senior Secondary students' achievement in Physics in Ikot Ekpene Local Government Area of Akwa Ibom State, Nigeria. Three hypotheses guided the study. The study adopted quasi-experimental using pretest and post-test group design. The population comprises all the Senior Secondary two Physics students of 2024/2025 session in co-educational Public Secondary School in Ikot Ekpene Local Government Area. The study sample comprised 130 physics students in two intact classes in the two schools in the study using purposive sampling technique. Physics Achievement Test on Equilibrium of Forces (PATEF) and adopted Cognitive Ability Test (CAT) with a reliability indices of 0.80 and 0.80 were instruments used for data collection. The instrument (PATEF) was validated by experts consisting of one senior academic staff from the Department of Science Education, Akwa Ibom State University, Ikot Akpaden, one senior academic staff in measure and evaluation University of Uyo and one experience Physics teacher within the selected schools for the study. The data were analyzed using descriptive statistics, while research hypotheses were tested at 0.05 level of significance using Analysis of Covariance (ANCOVA). The findings showed a significant difference between the mean achievement scores of Physics students when taught equilibrium of forces using guided inquiry and demonstration approaches, respectively in favour of demonstration approach. Similarly there was no significant difference between mean academic achievement scores of male and female Physics students' on the concept of equilibrium of forces when taught using guided-inquiry and demonstration approaches .Also there exists no significant difference among mean academic achievement scores of high, average and low students' abilities when taught the concept of equilibrium of forces using guided-inquiry and demonstration approaches. Based on the findings, demonstration approach was recommended for teaching of equilibrium of forces.

**Keywords:** demonstration, guided-inquiry, academic achievement, equilibrium of forces

## Introduction

Science is a body of empirical, theoretical and physical knowledge about the natural world produced by consistent and cumulative process which emphasize on observation, explanation and production of real-world phenomena using experimentation. According to Akpokinovo (2022), science is a systematic investigation of nature with a view to harnessing it to serve human needs. Science in secondary school level in Nigeria is offered in subjects like physics, biology and chemistry.

Physics is an aspect of science dealing with the basic questions on the structure of matter and the interactions of the element constituents of nature that owe susceptible to experimentations (Akinbobola, 2015). It is a core science subject of senior secondary school level in Nigeria and it is a requirement for entry into higher institutions in Nigeria for further study of science, engineering, aviation, astronomy and medicine. Despite the importance of physics to national development, it appears that most physics students perceive a number of physics concepts as difficult. Physics concepts are considered difficult when an academically average student performs poorly when evaluated especially when the teacher has put in his best in a series of instructional delivery (Omiko, 2017). According to Iji, Ogbole and Uka (2016), students perceive that teaching which emphasizes more on solving problems was a major or source of difficulty for them .The concept of equilibrium of forces is however perceived as being difficult (Taagahar and Okwori, 2022, Obafemi and Onwioduokit, 2013).This difficulty is

attributed to many factors including talk and chalk method, gender and cognitive ability (Iji, Ogbole and Uka, 2016).

Talk and chalk method is a verbal presentation of ideas, concepts, generalization and facts by the teachers who dominate the learning situation (Ogbodo, Etuk and Afangideh 2018). The teacher is seem as an expert and students are expected to contribute little to noting to the learning process. According to Aboh (2021), it is predominantly characterized by listening, copying of notes and memorizing of concepts which cannot give the desired results on student's performance. This method of teaching fails to sufficiently developed learners understanding of physics concepts thus promotes gender disequilibrium

According to Ohia (2018), gender is a sociocultural division between males and females, qualities associated with men and women that are socially than biologically determined. Gender has remained a burning issue and has also remained relevant in education because it has been linked to performance and participation in certain profession (Olufunke, 2022). Bebenimibo (2022) observed that female students performed better than male students in Basic Science while Zenbari and Blume (2013) report that boys perform better than girls in Mathematics and Science related courses while girls exhibited higher verbal ability. Olufunke (2022) showed that there is a significant gender difference in students' performances in science in favour of females. Studies on gender are inconclusive and conflicting thus affect students' cognitive ability.

Cognitive ability is a mental capacity that involves the ability to reason, plan, solve problems, think abstractly and learn from experience (Etukakpan, 2022). It is a brain –based skills that are needed in the acquisition of knowledge, the manipulation of information and reasoning .According to Etukakpan (2022), the cognitive ability is categorized into three levels, namely high, average, and low. These categories happened when students are deficient of memory, attention, processing and sequencing which are necessary for optimal learning. When students are affected in one or more of these essential cognitive tools, learning and acquisition of problems will occur.

These factors affect the performance of candidates in physics examination conducted by West African Examinations Council (WAEC) which is usually not encouraging as reports often showed (WAEC Chief Examiners Report CERs, 2014 -2022 ) fluctuating failures rate in physics over the years. For example, the failures rate in physics in 2014 was 54.7% while in 2015 and 2016 it fluctuates to 63.4% and 55.2% respectively. For the period 2014-2022 reported, the highest failure rate was recorded in 2022 with 65.29% of students' failure in the examination. In order to improve on these failure percentages and guarantee quality instruction in physics, emphasis has been on the use of appropriate teaching strategies that can enhance effective classroom interaction capable of giving equitable changes for students to acquire qualitative and right knowledge of subject matter (Aboh, 2021). For this reason, it is recommended that the use of demonstration and guided inquiry teaching approaches that takes students perception of difficult concepts into consideration be used (Akpokinovo 2022, Ekomaye 2019, Inyang, Uboh and Utibe, 2022 and Aluku and Odubanjo 2020). So, the use of demonstration and guided-inquiry approaches were therefore adopted in this study.

The Demonstration approach is a teaching approach in which the teacher performs the experiment to the students and encourages them to watch to deduce understanding. This approach encourages understanding and makes physics more interesting and less difficult to students. It is a method of teaching concepts, principles of real things by combining explanation with handling or manipulation of real things, materials or equipment (Akinbobola, 2015).

Guided-inquiry is an instructional method of teaching for teachers to act as a guide to enable students gets useful information to what is to be discovered in a topic. Guided inquiry approach is a teaching technique that is students-centered and activity oriented, thereby giving learners the opportunity to discover facts about a particular problem. Uwak and Stephene (2020) found a significant difference in the achievement of physics students when taught waves using guided inquiry and demonstration approaches, respectively. The reference to students' perception of equilibrium of forces as a contributory factor to their poor performance calls for urgent attention. It is on this note that this work sets to address the difficulties in the concept of equilibrium of forces. Edoho and Abasi (2019) also found that guided-discovery instructional strategy had great influence on students' academic performance and interest in geometry. It was concluded that guided-discovery instructional strategy helped to boost students' interest in learning mathematics thereby enhancing students' performance in mathematics.

## Purpose of the Study

The study is specifically set out to:

1. compare the mean academic achievement scores of physics students on the concept of equilibrium of forces when taught using guided inquiry and demonstration approaches, respectively.
2. Compare the mean academic achievement scores of male and female physics students on the concept of equilibrium of forces when taught using guided-Inquiry and demonstration approaches, respectively.
3. Determine the differences in the mean academic achievement scores of students of high, average and low cognitive abilities when taught the concept of equilibrium of forces using Guided-Inquiry and Demonstration approaches, respectively.

## Research Questions

The following research questions were raised for this study

1. What is the mean academic achievement score of physics students on the concept of equilibrium of forces when taught using guided inquiry and demonstration approaches?
2. What is the mean academic achievement scores of male and female physics students' on the concept of equilibrium of forces when taught using guided inquiry and demonstration approaches?
3. What are the mean academic achievement scores of students of high, average and low cognitive abilities when taught the concept of equilibrium of forces using guided inquiry and demonstration approaches?

## Research Hypotheses

The following null hypotheses were tested at 0.5 level of significance.

1. There is no significant difference between the mean academic achievement scores of physics students on the concept of equilibrium of forces when taught using guided inquiry and demonstration approaches.
2. There is no significant difference in the mean academic achievement scores of male and female physics students on the concept of equilibrium of forces using guided inquiry and demonstration approaches.
3. There is no significant difference among the mean academic scores of students of high, average and low cognitive abilities when taught the concept of equilibrium of forces using guided inquiry and demonstration approaches.

## Methods

A quasi-experimental research design with a non-randomized pre-test, post-test group was adopted in the study. The study is described as non-randomized since intact classes from selected schools were used. A total of 130 SS2 physics students were selected by purposive sampling technique based on the following criteria; schools that have qualified professional physics teachers with at least 5 years of teaching experience as subject teacher in SS2 classes, schools that have well equipped and functional physics laboratories, schools that are currently presenting candidates for West Africa Senior School Certificate Examination (WASSCE), public co-educational government schools and schools that have trained laboratory assistant. From the survey of the schools. All schools were found to have met the criteria. Two schools among all that met the criteria were selected by random sampling technique. One intact class per school were randomly selected .Intact classes were signed to experimental group one (guided-inquiry, male 32 and female 38) and experimental group two (demonstration, male 21 and female 29) by simple random sampling technique. Two researcher- made instruments were used in the study for data collection namely: Physics Achievement Test on Equilibrium of Forces (PATEF) and adopted Cognitive Ability Test (CAT). PATEF is made up of multiple choice objective test consisting of forty items (A, B, C and D) with only one correct answer and three distracters. Each right option carried score of one mark while distracter carried zero mark.

CAT: Usendia (2018) CAT was adopted for the study. It was used to categorize students' into different ability levels of high, average and low. A three man team of experts consisting of one senior academic staff from the department of science education, Akwa Ibom State University, Ikot Akpaden, one senior academic staff who is an expert in measure and evaluation from the University of Uyo and one experience physics teacher from the study area faced validated the instrument. The instrument was faced validated in terms of clarity of instruments; correct wording of items and appropriateness and adequacy of the items in addressing the purpose and problems of the study. The critical appraisal and comments of the experts were used for reformed in items. Based on their critical appraisal and comments, the 60 items in the draft of PATEF reduced to 40 items.

Validation of PATEF was done by a three man team of experts consisting of one senior academic staff from the department of science education, Akwa Ibom State University, Ikot Akpaden, one senior academic staff who is an expert in measurement and evaluation from the University of Uyo and one experience physics teacher from the study area. Kuder Richardson, 20 formula method was used to estimate the internal reliability coefficient (r) of PATEF in the study. A trial test was administered once to forty students in the school in the study area which was not part of the main study. Data obtained from PATEF were subjected to Kuder Richardson, 20 formula. The result yielded an internal consistency value of 0.80.

The following procedures were followed during the training and administration of the instrument. Week one, relevant permission were obtained from the principals of the two schools and research assistants and students informed of the purpose. Week two, research assistants were trained and undertook mock teaching. Those whose performance were found satisfactory were used as research assistants in the two selected schools for the conduct of the study. Thereafter, pretest was administered to the students (Intact class) at the end of mock teaching by their research assistants of the two schools selected. Week three, treatment by the research assistants using a prepared lesson note by the researchers under the following headings; resultant and equilibrium of forces, parallel forces and moment of a force (torque).Week four ,treatment under the following headings; centre of gravity and equilibrium of bodies in liquid. Week five, treatment under the following headings; Archimedes' principle and law of floatation. Week six, administration of posttest (reshuffled PATEF), collation and collection of marking and returned of the data to the Researchers. The data generated in the study were analyzed using mean, standard deviation, and Analysis of Covariance (ANCOVA) statistic .mean, standard deviation were used for answering the research questions, while ANCOVA was used in testing the three research hypotheses formulated. All the hypotheses were tested at .05 level of significance. Pretest were used as covariate.

## Results

**Table 1: Summary of the mean and standard deviation of academic achievement score of Physics Students on concept of equilibrium of forces when taught using guided inquiry and demonstration approaches.**

| Teaching Approaches | Pre-test | | Post- test | | Difference | |
|---|---|---|---|---|---|---|
| | N | Mean | SD | Mean | SD | |
| Guided -Inquiry | 70 | 22.52 | 4.01 | 41.12 | 5.47 | 18.60 |
| Demonstration | 6018.14 | 3.24 | 38.18 | 3.58 | 20.04 | |

Table 1 shows the mean achievement scores of students taught equilibrium of forces using Guided-Inquiry and Demonstration approaches, respectively. The result indicates that students taught equilibrium of forces using Demonstration approach (20.14) had higher mean achievement difference than Guided-Inquiry approach (18.60) .The post-test standard deviation scores, 3.58 for Demonstration method shows that the mean scores clustered around the mean than Guided-Inquiry approach (5.47).

**Table 2: Summary of mean and standard deviation of academic achievement scores of males and females Physics students**

| | | | Pretest | | Post Test | | Difference |
|---|---|---|---|---|---|---|---|
| Teaching Approaches | Gender | n | Mean | SD | Mean | SD | |
| Guided-Inquiry | Male | 32 | 21.72 | 6.52 | 43.85 | 6.31 | 22.10 |
| | Female | 38 | 20.31 | 5.99 | 41.32 | 4.15 | 21.01 |
| Demonstration | Male | 21 | 20.74 | 5.53 | 43.18 | 5.26 | 22.44 |
| | Female | 29 | 24.21 | 5.21 | 41.32 | 4.15 | 17.11 |

Table 2 shows the mean achievement scores of male students taught equilibrium of forces using Guided-Inquiry and Demonstration approaches, respectively. The result indicates that male students taught equilibrium of forces using Demonstration approach (22.44) had higher mean achievement difference than Guided-Inquiry approach (22.10). The post-test standard deviation scores, 5.26 for Demonstration method shows that the mean scores clustered around the mean than Guided-Inquiry approach (6.31).

Table 2 also shows the mean achievement scores of female students taught equilibrium of forces using Guided-Inquiry and Demonstration approaches, respectively. The result indicates that female students taught equilibrium of forces using Guided-Inquiry (21.01) had higher mean achievement difference than Demonstration

approach (17.11). The post-test standard deviation scores, 3.15 for Demonstration method shows that the mean scores clustered around the mean than Guided-Inquiry approach (4.13).

**Table 3: Summary of mean and standard deviation of academic achievement scores of high, average and low cognitive ability of students**

| | | | Pre-test | | Post- test | | Difference |
|---|---|---|---|---|---|---|---|
| Teaching Approaches | Cognitive Levels | n | Mean | SD | Mean | SD | |
| Guided-Inquiry | High | 13 | 21.45 | 6.03 | 43.53 | 6.08 | 22.08 |
| | Average | 24 | 18.43 | 5.42 | 39.45 | 5.02 | 21.02 |
| | Low | 33 | 16.52 | 5.54 | 36.85 | 6.27 | 20.33 |
| Demonstration | High | 12 | 22.28 | 5.36 | 41.26 | 6.43 | 18.98 |
| | Average | 20 | 20.78 | 5.99 | 37.91 | 6.28 | 17.13 |
| | Low | 28 | 18.22 | 5.03 | 34.11 | 5.54 | 15.89 |

Table 3 shows the mean achievement scores of students of high cognitive ability taught equilibrium of forces using Guided-Inquiry and Demonstration approaches, respectively. The result indicates that students of high cognitive ability taught equilibrium of forces using Guided-Inquiry approach (22.08) had higher mean achievement difference than Demonstration approach (18.98). The post-test standard deviation scores, 6.08 for Guided-Inquiry shows that the mean scores clustered around the mean than Demonstration approach (6.43).

Table 3 also shows the mean achievement scores of students of average cognitive ability taught equilibrium of forces using Guided-Inquiry and Demonstration approaches, respectively. The result indicates that students of average cognitive ability taught equilibrium of forces using Guided-Inquiry method (21.02) had higher mean achievement difference than Demonstration approach (17.13). The post-test standard deviation scores, 5.02 for Guided-Inquiry shows that the mean scores clustered around the mean than Demonstration approach (6.28).

Table 3 further shows the mean achievement scores of students of low cognitive ability taught equilibrium of forces using Guided-Inquiry and Demonstration approaches, respectively. The result indicates that students of low cognitive ability taught equilibrium of forces using Guided-Inquiry method (20.33) had higher mean achievement difference than Demonstration approach (15.89). The post-test standard deviation scores, 5.54 for Demonstration approach shows that the mean scores clustered around the mean than Guided-Inquiry (6.27).

**Table 4: ANCOVA summary of the difference between the mean academic achievement scores of physics students on concept of equilibrium of forces using pretest as covariate**

| **Source** | **Type III Sum of Squares** | **df** | **Mean Square** | **F** | **Sig** |
|---|---|---|---|---|---|
| Corrected Model | 883.805[a] | 3 | 294.602 | 0.742 | 0.528 |
| Intercept | 86353.098 | 1 | 86353.098 | 217.607 | 0.000 |
| Pretest | 245.975 | 1 | 245.975 | 0.620 | 0.432 |
| Group | 650.497 | 2 | 325.249 | 0.820 | 0.004 |
| Error | 61111.847 | 123 | 396.830 | | |
| Total | 508259.000 | 130 | | | |
| Corrected Total | 61995.652 | 129 | | | |

a. R Squared = 0.014 (Adjusted R Squared = -0.005)

Result in the analysis in table 4 showed that the calculated F-value of .820 in respect of the treatment as main effect has a probability value of 0.004 and therefore significant at 0.05 level of significance. Therefore the null hypothesis stating no significant difference between the mean achievement scores of physics students on the concept of equilibrium of forces when taught using guided inquiry and demonstration approaches, respectively is rejected. This implies there is a significant difference between the mean achievement scores of physics students on the concept of equilibrium of forces taught using guided inquiry and demonstration approaches, respectively in Ikot Ekpene Local Government Area, Akwa Ibom State.

**Table 5: ANCOVA summary of the difference between mean academic achievement scores of male and female Physics students on the concept of equilibrium of forces using pretest as covariate**

| **Source** | Type III Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Corrected Model | 4791.553[a] | 3 | 798.592 | 2.016 | 0.067 |
| Intercept | 76766.766 | 1 | 76766.766 | 193.799 | 0.000 |
| Pretest | 20.059 | 1 | 20.059 | 0.051 | 0.822 |
| Group | 1739.126 | 2 | 869.563 | 2.195 | 0.115 |
| Gender | 238.028 | 1 | 238.028 | 0.601 | 0.439 |
| Group * Gender | 1733.912 | 2 | 866.956 | 2.189 | 0.116 |
| Error | 59813.308 | 120 | 396.115 | | |
| Total | 538384.000 | 130 | | | |
| Corrected Total | 64604.861 | 129 | | | |

Result in the analysis in table 5 showed that the calculated F-value of 0.601 in respect of the treatment as main effect has a probability value of 0.439 and therefore not significant at 0.05 level of significance .Therefore the null hypothesis stating no significant difference between the mean achievement scores of male and female physics students on the concept of equilibrium of forces when taught using guided inquiry and demonstration approaches, respectively is retained. This implies no significant difference between the mean achievement scores of male and female in the concept of equilibrium of forces when taught using guided inquiry and demonstration approaches, respectively in Ikot Ekpene Local Government Area, Akwa Ibom State.

**Table 6 : ANCOVA summary of the difference among mean academic achievement scores of high, average and low cognitive abilities when taught the concept of equilibrium of forces using pretest as covariate.**

| Source | Type III Sum of Squares | df | Mean Square | F | Sig |
|---|---|---|---|---|---|
| Corrected Model | 11564.428[a] | 8 | 1445.554 | 3.945 | 0.000 |
| Intercept | 25872.058 | 1 | 25872.058 | 70.614 | 0.000 |
| Pretest | 4384.914 | 1 | 4384.914 | 11.968 | 0.001 |
| Group | 2264.398 | 2 | 1132.199 | 3.090 | 0.048 |
| Cognitive_Level | 2808.863 | 2 | 1404.432 | 3.833 | 0.024 |
| Group * Cognitive_Level | 920.926 | 3 | 306.975 | 0.838 | 0.003 |
| Error | 54591.648 | 113 | 366.387 | | |
| Total | 500070.000 | 130 | | | |
| Corrected Total | 64845.523 | 129 | | | |

Result in the analysis in table 6 showed that the calculated F-value of 3.833 in respect of the treatment as main effect has a probability value of 0.024 and therefore not significant at 0.05 level of significance. Therefore the null hypothesis stating no significant difference among the mean achievement scores of students of high, average and low abilities on the concept of equilibrium of forces when taught using guided inquiry and demonstration approaches, respectively is retained. This implies no significant difference among the mean achievement scores of students of high, average and low abilities on the concept of equilibrium of forces when taught using guided inquiry and demonstration approaches, respectively in Ikot Ekpene Local Government Area, Akwa Ibom State.

## Discussion of Findings

The result in table 4 showed a significant difference existed between the mean academic achievement scores of Physics Students' on the concept of equilibrium of forces when taught using guided inquiry and demonstration approaches, respectively in favour of demonstration approach. The findings indicated that when students observed their teacher demonstrates live experiment in the concept of equilibrium of forces, it sparks curiosity, encouraged active participation and students achievement improved than the approach which will expect the students to discover facts by guiding. The study is in line with Uwak and Stephene (2020) who found a

significant difference in the achievement of physics students when taught waves using guided inquiry and demonstration approaches, respectively in favour of demonstration approach.

Findings on gender showed that gender was not statistically significant when students were taught using guided inquiry and demonstration approaches, respectively. This observation indicates that gender is not a strong determinant of students' academic achievement .The no statistically significant of gender observed in the study agrees with assertion made by Akinbobola (2015) that male and female students do not differ in academic achievement when taught using guided inquiry and demonstration approaches, respectively.

Table 6 also showed cognitive ability not statistically significant on the concept of equilibrium of forces when taught using guided inquiry and demonstration approaches, respectively. In other word, students' cognitive ability is not a strong determinant of students' academic achievement in the concept of equilibrium of forces when taught using guided inquiry and demonstration approaches, respectively. The findings of the study is in agreement with the submission made by Etokakpan (2022) that the cognitive ability of students is not a major determinant of academic achievement.

## Conclusion

It was concluded that demonstration approach should be adopted to enhance academic achievement of students regardless of gender and cognitive ability especially in the concept of equilibrium of forces in Ikot Ekpene Local Government Area of Akwa Ibom State.

## Recommendations

1. Teachers should utilize demonstration approach for the teaching of male and female students as the approach engages all learners equally and reduce gender stereotype.
2. Teachers should embrace the use of demonstration approach for teaching equilibrium of forces to improve academic achievement of students regardless of their cognitive abilities.
3. Government should regularly organize and monitor workshops, seminars and conferences for teachers on the use of demonstration to enhance teachers' expertise.

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