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Impact of Inductive Approach on Academic Performance in Algebra among Senior Secondary School Students in Gusau Metropolis, Zamfara State, Nigeria

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Abstract

This study assesses the impact of inductive approach on students' academic performance in Gusau Metropolis, Zamfara State, Nigeria. The study was guided by two research questions, each with its corresponding null hypothesis. The study employed a quasi-experimental design entailing pre-test and post-test. The population of the study comprised all senior secondary school students (SSII) in Gusau Metropolis. There are four thousand eight hundred and sixty-six (4866) students in the population, where three thousand three hundred and eighty-nine (3389) were male and one thousand four hundred and seventy-seven (1477) were female. Two schools were selected using simple random sampling techniques through a ballot method out of twenty-six (26) schools in Gusau metropolis. The schools were randomly assigned to experimental and control groups. Algebra Performance Test (APT) was the instrument used for data collection. The instrument was validated by five experts, including three experienced secondary school Mathematics teachers. The pilot test was conducted in a school that is out of the sample but part of the population. The result of the pilot test was used to obtain a reliability index of 0.83. The experimental group was taught Algebra using inductive approach while the control group was taught using conventional method. The APT was administered to both groups before and after the treatment. The stated research questions were answered using descriptive statistics, while the null hypotheses were analyzed using independent sample t-test at 0.05 level of statistical significance. The findings indicate that when students were taught Algebra using inductive approach, they performed better than when they were exposed to conventional method. Also, male students performed better than their female counterparts when taught Algebra using inductive approach. In light of these findings, the researcher recommends that teachers be taught how to utilize the inductive approach through a series of seminars and workshops.

Keywords: Algebra, Academic Performance, Inductive Approach

Introduction

Mathematics plays a significant role in the life of an individual, ranging from health, income, satisfaction with life, employability, and well-being (Abín, et al., 2020). Mathematics is concerned with nature and everyday problems; it also involves imagination, intuition, and reasoning to find solutions to human unending problems (Ali Khan, 2015). Mathematics started based on inductive reasoning through man's experience with nature, and trying to explore nature and make his life more comfortable and enjoyable (Ali Khan, 2015). The application of inductive reasoning, even in our daily lives, cannot be overemphasized. Whether one is aware or unaware, inductive reasoning is employed to make a decision and draw a conclusion from previous experience. Therefore, the inductive approach is the basic approach of exploring the concepts of Mathematics and applies to many educational levels of the learners (Ebrahim, 2010).

Algebra is a branch of Mathematics that deals with abstract concepts. The real-life problems are transferred to algebraic expressions or equations. Algebra is not just an aggregation of letters and symbols with no meaning or value, but it represents a certain variable in the real world (Odumosu & Areelu, 2018). Many people find it difficult to use basic operations in Mathematics, talk less of representing or expressing that operation in the form of a relationship between two or more variables (Wee, et al., 2021). Some of the research indicated very poor performance of students in Algebra, and this concept plays a significant role in the advanced study of Mathematics (Matthews & Farmer, 2008) The performance of students in Algebra can be improved through the use of student-centered teaching methods, such as concept mapping and inductive approach (Adisa & Abiola, 2021). Students who were taught Algebra using concept mapping performed significantly higher than those taught using the conventional method (Adisa & Abiola, 2021). Secondary school teachers always search for good and reliable strategies in teaching Algera, such strategies should be student-centered strategies (Obafemi & Ahumaraeze, 2025)

Students' academic performance has become a lingering issue in Mathematics. Teachers and all concerned educational stakeholders are working tirelessly to remedy the situation. Many alternatives were tested, ranging from teachers'

factors, students' factors, school factors, administrative challenges, to poor teaching strategies (Odumosu & Areelu, 2018; Sosa-Moguel & Aparicio-Landa, 2021). The academic performance of students was measured in both internal and external examinations, but the results show a very poor performance of students in Mathematics. Many students find Mathematics difficult; this difficulty is not attached to the content of Mathematics or the teachers, but rather the strategies employed by the mathematics teachers (Islam & Rafi, 2020).

The inductive teaching approach is a teaching method that requires evidence gathering, critical thinking, by providing a sufficient number of examples, and drawing a formula or generalization from the specific examples (Adams et al., 2021). The inductive approach starts from several particular cases and generalizes, from concrete to abstract, from known to unknown, and from simple to complex (Adams et al., 2021; Islam & Rafi, 2020). The inductive method of teaching is based on induction. Induction means to offer a general truth by showing that if it is true for a particular case, it is true for all cases. The inductive method in the world of mathematics is a method of constructing a formula with the help of a sufficient number of concrete, actual, and real examples (Sosa-Moguel & Aparicio-Landa, 2021). An inductive approach is used by Mathematics teachers to develop formulas and rules. The inductive approach requires the teacher to give sufficient examples before generalizing. The teacher has to make sure that the rules are followed. See example below

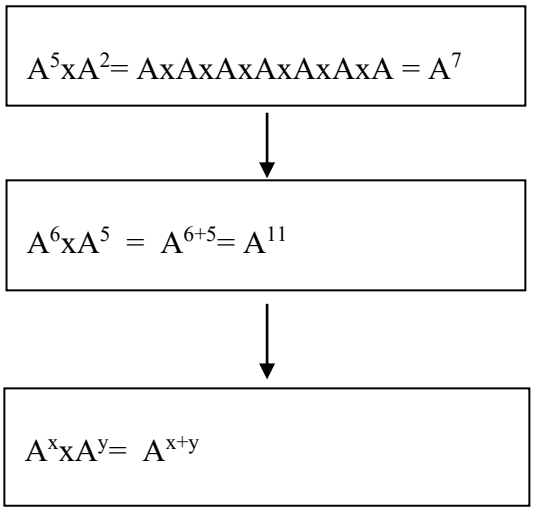

Figure 1: Examples of Inductive Approach in Indices
Source: Developed by the researcher

In Figure 1 above, the teacher has to provide sufficient examples of evaluating indices by counting the number of times a particular variable appears. The next step is to provide a sufficient number of examples by adding the power of variables to get the results. Then, here comes the generalization for any arbitrary number. Whenever two indices are multiplied together, we add their powers Generally inductive approach takes the following steps

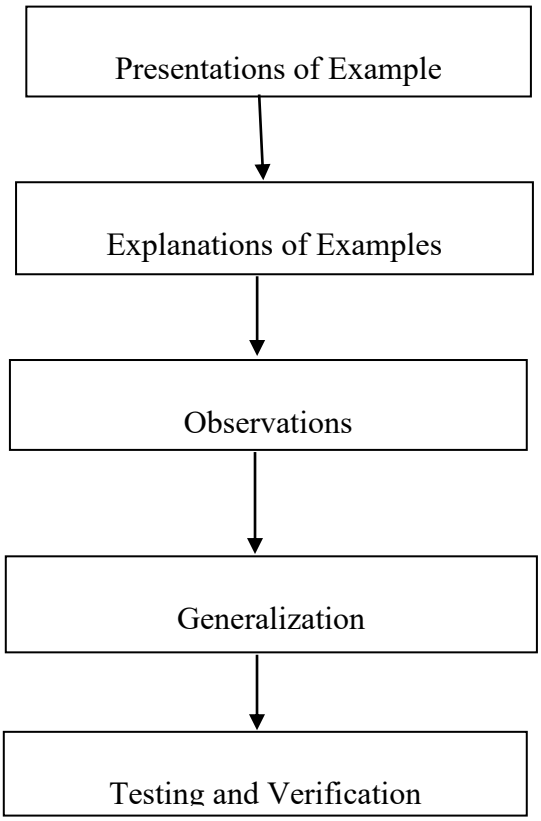

Figure 2: Steps in Inductive Approach
Source: Islam and Rafi (2020)

The inductive approach was found to be beneficial in improving students' academic performance. Inductive approach was found to enhance students' reasoning ability in Mathematics and in Algebra in particular, compared to a conventional teaching method (Sosa-Moguel & Aparicio-Landa, 2021).Furthermore, according to Taa, (2022), Students taught Mathematics using inductive approach performed better than those taught using conventional method. So, also the higher ability students performed better than the lower and average ability students when exposed to inductive approach. The research shows no significant difference in the performance of males and

females exposed to inductive teaching approach. The use of problem-based learning method has a significant influence on students' academic achievement in Algebra compared to the conventional method (Donatus James, 2023). Similarly, the researcher found no significant difference in gender when taught Algebra using problem-based learning strategy. According to the findings of Akinoso (2019), inductive teaching strategy influences students' academic performance than the conventional teaching method, but has no effect on gender. Both male and female students can perform equally well when taught Mathematics using inductive approach. Furthermore, research has shown that inductive method helps to improve the first three components of the cognitive domain in Algebra (Islam & Rafi, 2020). This research also indicates no significant influence of inductive approach on gender. Kaur, (2019), in trying to find out the effectiveness of inductive and deductive methods in Mathematics. His findings indicate a significant difference in the achievement score of students taught Mathematics using inductive approach and those taught using conventional method, but found no significant difference between deductive and inductive methods. Inductive teaching method is not only applied in Mathematics but also in other subjects. Inductive approach has proven significant influence on the performance of students in basic science (Adams et al., 2021).

Statement of the Problem

The achievement of mastery in higher education in Algebra and Mathematics in general relies on a solid foundation laid at the primary and secondary schools. If the foundation is too weak, higher education may not meet the required needs of the nation. Thus, Mathematics teaching and learning in both primary and secondary schools across Nigeria leave much to be desired, as evidenced by the poor performance of students in both internal and external Mathematics examinations. The poor performances of students in Mathematics at the secondary level pose a serious concern to the educational system in Nigeria. In the years 2005 to 2008, the Senior Secondary Certificate Examination (SSCE) Mathematics paper was cancelled throughout due to leakages of question papers. One could notice that the marking of Senior Secondary Certificate Examination (SSCE) is enough to get any concerned person sad about students' Performance in Mathematics in our schools today. Some candidates submitted blank scripts, many recopied the questions, and a good number of those who attempted to answer the questions ended up scoring below pass marks. In centers where reasonable degrees of success were

recorded, hallmarks of cheating, such as centers committing the same right and wrong, were observed.

In Zamfara state, the Ministry of Education in 2022 reported that the results of the West African

Examination Council (WAEC) out of twenty-five thousand and forty (25,040) candidates who sat for the examination, only five thousand and eight (5008) candidates, representing 20%, managed to obtain five credits including Mathematics. When the National Examination Council (NECO) of the same year was released, six thousand five hundred and fifty-three (6,553) candidates representing 25% out of twenty-six thousand two hundred and twelve (26,212) candidates representing 75% failed to get five credits, including Mathematics. By the above reasons, it has clearly showed that the massive failure of students in mathematics is a result of poor teaching methods adopted by mathematics teachers in various secondary schools.

The above captures the general performance of students in Mathematics. In particular, Algebra is among the most difficult concepts in Mathematics. This may not be unconnected with the use of symbols and letters to represent quantity or a variable. The hatred and poor performance of students in Algebra can be seen in the WAEC Chief examiners' reports of 2019, 2020, and 2021. For the consecutive three years, students failed to attempt questions in Algebra, and even those who attempted were wrong. This poor performance and hatred of Algebra may not be unconnected with the poor teaching methods employed by secondary school teachers. It is one of the suggestions for the remedy of this ugly situation; the Chief Examiner recommended the use of some learner-centered teaching method. This can be achieved through the use of inductive approach. As such, the researcher used Inductive approach of teaching to investigate the performance of students in Algebra in senior secondary schools in Gusau metropolis.

Objective of the Study

The main objective of this study is to investigate the effect of the inductive method in Algebra on the performance of senior secondary school students in Gusau, Zamfara state. Specifically, the study was carried out to;

1. Investigate the impact of the Inductive method in enhancing students' performance in Algebra in Gusau Metropolis.

2. Determine the performance of male and female students taught Algebra using inductive approach in Gusau Metropolis.

Research Questions

1. What is the difference between the mean academic performance of students taught Algebra using inductive approach and those taught using conventional method in Gusau metropolis?
2. Is there any significant difference between the mean academic performance of male and female students taught Algebra using inductive approach in Gusau metropolis?

Null Hypothesis

Based on the research questions, the following null hypotheses were formulated and tested at $P \leq 0.05$ level of statistical significance

H_{O1}: There is no significant difference between the mean academic performance of students taught Algebra using inductive approach and those taught using conventional method in Gusau metropolis.

H_{O2}: There is no significant difference between the mean academic performance of male and female students taught Algebra using inductive approach in Gusau metropolis

Methodology

The research was conducted in Gusau Metropolis, Zamfara State, Nigeria. The study employed a quasi-experimental design entailing pre-test and post-test. The design involves Control Group (CG) and Experimental Group (EG). The control group was taught Algebra using the conventional method, while the experimental group was taught Algebra using inductive approach. The treatment lasted for four weeks. The population of the study includes all senior secondary school students in Gusau Metropolis. The total number of students in Gusau metropolis is four thousand eight hundred and sixty-six (4866). The population includes three thousand three hundred and eighty-nine (3389) males and one thousand four hundred and seventy-seven (1477) female students. Since the study employed a quasi-experimental design, which accommodates non-random assignment, the study used intact classes. Therefore, two schools were chosen using simple random sampling techniques through a balloting method out of twenty-six schools in Gusau metropolis. The

two schools chosen were assigned as the control and experimental groups. In the control group, there are seventy (70) males and 37 females. In the experimental group, there are fifty-five (55) males and thirty-five (35) females. The instrument used in this research is the Algebra Performance Test (APT). The instrument consists of forty (40) multiple-choice questions. Each questions carry one mark. The instrument was validated by five experts. Three out of five were experienced secondary school Mathematics teachers. One is a senior lecturer from the Department of Science Education, Ahmadu Bello University, Zaria. The fifth is also a senior lecturer from the Department of Counselling Psychology, Ahmadu Bello University, Zaria. The pilot study was conducted in one of the schools in Gusau Metropolis. The school is not part of the sample but is contained in the population of the study. The pilot test was split into two halves and was analyzed using Pearson Product-Moment Correlation. The reliability index was found to be 0.83. The study took seven (7) weeks to complete and was conducted by the researchers physically. The instrument was administered before and after the intervention. The pre-test results show that the two groups were homogeneous. The descriptive statistics were used to answer the research questions. The independent sample t-test was used to analyze the null hypotheses at 0.05 level of statistical significance.

Results

The results of two stated research questions and null hypotheses are presented in tables and figures below.

Research Question One: What is the difference between mean academic performance of students taught Algebra using inductive approach and those taught using conventional method?

Table 1: Students' Performance in Experimental and Control Groups

Group	N	Mean	Std Dev.
Experimental	90	32.18	5.35
Control	107	21.16	5.25

Source: Field data

Table 1 above shows that the experimental group gained a mean academic performance of 32.18 with a standard deviation of 5.35. The control group gained a mean academic performance of 21.16 with a standard deviation of 5.25. Therefore, the experimental group performed better than the control group. This gain in the mean performance score of experimental groups may not be unconnected with the intervention.

Research Question Two: Is there any significant difference between mean academic performance score of male and female students taught Algebra using inductive approach?

Table 2: Male and Female Performance in the Experimental Group

Gender	N	Mean	Std Dev.
Male	55	25.38	7.28
Female	35	21.16	5.98

Source: Field data

Table 2 indicates that male students gain a mean academic performance of 25.38 with a standard deviation of 7.28. The female students got a mean academic performance of 21.16 with a standard deviation of 5.98. Male students performed better than their female counterparts. Therefore, the inductive approach favors male than female students.

HO1: There is no significant difference between the mean performance score of students taught Algebra using inductive approach and those taught using conventional method.

Table 3: Independent Sample t-test Results of Experimental and Control Groups

Group	**N**	**Mean**	**Std. Dev.**	**P-value**	**Decision criterion**
Experimental	90	32.18	5.35		
				0.001	Rejected
Control	107	21.16	5.25		

Decision Criterion: Reject Ho if P≤0.005
Source: Field data

Table 3 presents the results of experimental and control groups. Since the P-value is 0.001 less than 0.005, the stated null hypothesis must be rejected. Therefore, there's a significant difference in the mean performance score of students taught Algebra using inductive approach and those taught using conventional method. This difference can also be seen in their mean performance score.

HO2: There is no significant difference between the mean performance score of male and female students taught Algebra using Inductive approach.

Table 4: Independent Sample t-test of Male and Female in Experimental Group

Gender	**N**	**Mean**	**Std. Dev.**	**P-value**	**Decision criterion**
Male	55	25.38	7.28		
				0.001	Rejected
Female	35	21.16	5.98		

Source: Field data

Table 4 above indicates the mean performance score of males as 25.38 with a standard deviation of 7.28. Female students have a mean performance score of 21.16 with a standard deviation of 5.98. The stated null hypothesis was rejected. This confirms that there's a significant difference in the mean performance score of males and females taught Algebra using inductive approach.

Discussion

The findings of this research indicate that students who were taught Algebra using an inductive approach performed better than students who were taught Algebra using the conventional method. This finding was supported by (Adams et al., 2021; Akinoso, 2019; Donatus James, 2023; Islam & Rafi, 2020; Kaur, 2019). All their findings show that students taught Algebra and other Mathematics concepts using an inductive approach performed better than students exposed to the conventional method.

Our findings with regard to gender indicate that male students performed better than their female counterparts. This finding is supported by Taa (2022). Male students performed better than female students when taught Algebra using inductive approach. Nevertheless, the findings of this research with regard to gender were against the findings of (Donatus James, 2023; Islam & Rafi, 2020; Kaur, 2019). In their findings, they found that inductive approach is gender-friendly.

Conclusion

In conclusion, the inductive approach is a very good teaching method in teaching and learning Mathematics. The approach has proven to have immense benefits when it is employed. Many research has shown that inductive approach is far better than the conventional method. But there is a controversial finding with regard to the impact of inductive approach to gender. Some research findings indicate that both male and female students can perform equally well. While some indicate that male students performed better than their female counterparts.

Recommendations

Based on the findings of this study, the following recommendations were made:

1. Mathematics teachers should be trained in the effective use of inductive teaching strategy through a series of workshops and seminars.
2. Students should be engaged through inductive approach to discover general rules or formulas by themselves.
3. Curriculum planners should recommend the use of inductive approach in developing Mathematics curriculum for some concepts in Mathematics where it is more appropriate to use the strategy.

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