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Impact of Inducto-Deductive Approach on Academic Performance in Arithmetic Progression among Senior Secondary School Students in Zaria Metropolis, Kaduna State, Nigeria

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Abstract

This study investigated the effect of the inducto-deductive approach on students' academic performance in Arithmetic Progression in Zaria Metropolis. The study was guided by two objectives and two corresponding research questions. A pretest–posttest non-equivalent control-group quasi-experimental design was adopted. The population comprised 4,021 secondary school students in Zaria Metropolis. Two schools were selected through simple random sampling, with one school assigned to the experimental group and the other to the control group. Intact classes were retained, resulting in 93 students in the experimental group and 91 students in the control group. Data were collected using the Arithmetic Progression Performance Test (APPT), a 10-item essay-type test with a maximum score of 100. The instrument was subjected to content validation by four experienced secondary school Mathematics teachers. Its reliability was established using the split-half method; the two halves yielded a Pearson Product-Moment Correlation coefficient of 0.76, which, after Spearman–Brown correction, produced a reliability coefficient of 0.86. Data were analyzed using descriptive statistics to answer the research questions, while Analysis of Covariance (ANCOVA) was used to test the hypotheses at the 0.05 level of significance, with pretest scores serving as the covariate. The findings indicated that students taught Arithmetic Progression using the inducto-deductive approach performed significantly better than those taught using the conventional approach. The findings further indicated that there was no statistically significant gender difference in students' performance when the inducto-deductive approach was employed. The study recommends that Mathematics teachers should consider the inducto-deductive approach in teaching Arithmetic Progression by engaging students in observing specific examples, identifying patterns and relationships, formulating general mathematical rules, and applying the rules to solve related problems.

Keywords: inductive, deductive, inducto-deductive, arithmetic progression, academic performance

1 Introduction

The introduction should be succinct and contain no subheadings. This section should present background for the study, The importance of Mathematics in nation-building and progress cannot be measured merely by verbal propositions. The application of Mathematics can be seen by all and sundry. This application is not limited to business, science, technology, administrative activities, agriculture, and many other areas. Mathematics is the study of numbers, quantities, shapes, patterns, logical relationships, critical examinations, and creativity (Aksu & Kul, 2019; Oginni et al., 2021; Yadav & Kumar Yadav, 2017; Yazlık & Çetin, 2020). The development of any nation may be tied to the development and progress of its education sector. Mathematics plays a fundamental role in nation building because it provides the intellectual and quantitative foundation necessary for scientific advancement, technological innovation, economic development, and evidence-based decision-making. Beyond the acquisition of computational skills, mathematics develops individuals' abilities in logical reasoning, critical thinking, problem-solving, quantitative analysis, and the interpretation of data, which are increasingly essential for effective participation in contemporary economic and social systems. The Organization for Economic Co-operation and Development (OECD, 2024) maintains that mathematical knowledge and related competencies are essential to economic growth, social well-being, and equity, while mathematical reasoning, statistical literacy, and the capacity to apply mathematical knowledge to real-world situations are increasingly important in a rapidly changing technological era. Similarly, the United Nations Educational, Scientific and Cultural Organization (UNESCO, 2024) identifies Science, Technology, Engineering, and Mathematics (STEM) as a critical tool for

innovation, economic growth, and sustainable development in Africa, emphasizing the importance of strengthening STEM ideas to harness the vast human resources. Consequently, effective mathematics education contributes to the development of a skilled and adaptable human capital capable of supporting technological transformation, solving complex societal problems, improving productivity, and contributing meaningfully to sustainable national development.

An inductive approach is a teaching strategy based on common rules or axioms. This can be shown by testing many specific instances before concluding. (Iyanda & Sam-Kayode, 2024; Rahmah, 2017).After testing several specific instances and found to be true for all the cases and it can be true for an arbitrary case. This method is found to develop students' curiosity, critical thinking, and problem-solving skills. (Okigbo & Nwigboji, 2025; Iyanda & Sam-Kayode, 2024). Learners may be curious to see many different cases hold for a particular value and find a generalization for an arbitrary value. This is what happens in AP. One has to test the progression for several known values before generalizing for an arbitrary value. AP is better taught and well understood when an inductive approach is employed. (Nkepah, 2022) A deductive approach is a teaching strategy the test specific instances from a general form to ascertain how true it may hold for all known values. (Nkepah, 2022; Imam et al., 2018; Rahmah, 2017). The approach starts from abstract to concrete and from general to specific. (Imam et al., 2018). This method is good in testing theories or hypotheses. The essence is to see whether the theory may be true in some specific instances. This method can help in memorization and develop students' problem-solving skills. (Taa, 2022). This method is applicable in teaching AP. Students can be given formulas to try different examples with different known values.

The inducto-deductive approach is a teaching approach that combines the inductive and deductive approaches. The inducto-deductive approach combines the strengths of the two approaches. So, this approach is better than either inductive or deductive if treated separately. In the inductive phase, students explore specific examples using known values and identify patterns, facilitating the discovery of general mathematical rules or formulas through active engagement (Okigbo & Nwigboji, 2025). The deductive phase then involves applying these rules or formulas to solve mathematical problems or examples, reinforcing understanding and promoting retention of concepts and problem-solving skills (Okigbo & Nwigboji, 2025). The inducto-deductive approach enhances students' performance in mathematics and positively influences their interest and motivation (Iyanda & Sam-Kayode, 2024; Okigbo & Nwigboji, 2025). Academic Performance is the measure of the learning outcome on a particular concept within a particular period. This is achieved through the administration of a valid examination that aims to measure students' strengths or weaknesses on a particular concept. (Mohammed, 2018; Oginni et al., 2021; Suglo et al., 2023) . The students' academic performance is always seen to improve with the application of innovative teaching strategies. (Donatus, 2023). To improve students' performance, teachers have to employ the most appropriate teaching techniques for each concept. A particular teaching strategy may be the best strategy for a particular concept and a worse strategy when applied to another concept. Empirical evidence indicates that instructional approaches that promote active participation, collaboration, problem solving, and meaningful engagement can produce better learning outcomes than approaches based predominantly on passive lecture. (Mohammed Abdel-hakam, 2018; Oginni et al., 2021; Suglo et al., 2023; Yasmin, 2015). Therefore, the choice and quality of teaching strategy can play a significant role in improving students' engagement, conceptual understanding, problem-solving ability, and ultimately their academic performance.

Students' academic performance in Arithmetic Progression (AP) can be strengthened through an inductive-deductive approach that combines the discovery of mathematical patterns with the subsequent application of established principles. Recent studies support the relevance of combining these approaches. Iyanda and Sam-Kayode (2024) reported significant effects of inductive and deductive teaching strategies on students' learning in Basic General Mathematics. Raheem (2024) found a significant interaction effect involving inductive and deductive strategies on students' academic achievement in Further Mathematics. Moreover, evidence specifically concerning Arithmetic Progression indicates that students exposed to an interactive learning approach performed better than those taught through conventional instruction, suggesting that active engagement with mathematical patterns and relationships may be particularly valuable for AP learning. Therefore, the inducto-deductive approach provides a theoretically and empirically defensible method for teaching Arithmetic Progression because it enables students to discover patterns inductively, formulate or understand mathematical rules, and subsequently apply those rules deductively, with the potential to improve their academic performance. Mathematics has been a good catalyst in learning other subjects and a yardstick for scientific and technological advancement. Even with the emergence of Artificial Intelligence (AI), Mathematics cannot be underscored because it plays a significant role in Machine Learning (ML) and many aspects that led to the development of AI. But even with these immense benefits, every year's report indicates a significant failure in Mathematics. This failure was due to either the complexity of some topics or teachers' negligence in applying the appropriate instructional strategy. Evidence from analyses of WAEC Chief Examiners' Reports of 2021, 2025 and 2026 has identified difficulties among students in applying Arithmetic Progression

concepts, particularly in problems involving the application of Arithmetic Progression and the determination of the sum of the nth terms. However, performance in this area has varied across examination years, with some reports indicating satisfactory performance on particular Arithmetic Progression questions

Arithmetic Progression should be a simple concept to be understood by the students due to its application to the students' immediate environment and does not involve rigorous abstract Mathematics but some little application of basic operations and symbols. Unfortunately, this concept was reported to be difficult or not attempted by the students in the past WAEC such as in the year 2021, 2025, and 2026. Among the suggestions reported by the Chief Examiner was that the teachers should be specific in selecting teaching methods, not one method for all the concepts, and should teach the students the basic principles and skills in the topic that they are weak in. The researchers find it necessary to test the inductive-deductive approach on the concept of AP. This research will benefit students, teachers, policy makers, curriculum planners, authors, researchers, professional organizations, and other educational stakeholders.

1.1 Objectives of the Study

The objective of this study is to investigate the impact of the inducto-deductive approach on academic performance in Arithmetic Progression (AP) among senior secondary school students in Zaria metropolis, Kaduna State, Nigeria. The study aims to achieve the following.

1. Examine the academic performance of students taught AP using the inducto-deductive approach and those taught using the conventional approach
2. Determine the academic performance of male and female students taught AP using the inducto-deductive approach.

1.2 Research Questions

The following research questions were generated to guide the study.

1. What is the mean academic performance of students taught AP using an inducto-deductive approach and those taught using a conventional approach?
2. What is the mean academic performance between male and female students taught AP using an inducto-deductive approach?

2 Literature Review/Theoretical Framework

Rajni (2018) and Iyanda and Sam-Kayode (2024) both reported that inductive and deductive teaching strategies significantly improved students' mathematics achievement compared with conventional teaching methods. However, their findings differed concerning the relative effectiveness of the two approaches. While Rajni (2018) found no significant difference between students taught using inductive and deductive methods, Iyanda and Sam-Kayode (2024) reported greater achievement among students taught using the deductive method. This contrast suggests that the relative effectiveness of inductive and deductive instruction may not be uniform across different teaching contexts or mathematical topics. It also raises the question of whether differences in lesson organization, students' prior knowledge and the nature of the mathematical concepts influence achievement.

A different perspective emerges from Rahmah (2017), who found no significant difference in mathematical problem-solving ability between students taught using the inductive-deductive approach and those taught using conventional instruction. This finding contrasts with Imam et al. (2018), who reported that the inductive-deductive approach significantly improved students' mathematical problem-solving skills and self-efficacy compared with the conventional method. The disagreement is particularly relevant because both studies considered the combined inductive and deductive approach and mathematical problem-solving. It indicates that the benefits of combining inductive and deductive reasoning may depend on how the approach is implemented, the characteristics of the learners or the instructional conditions. The difference also highlights the need to distinguish between achievement and problem-solving as outcomes, rather than assuming that improvement in one necessarily translates into improvement in the other.

Nkepah (2022) and Okigbo and Nwigboji (2025) provide further evidence concerning the effectiveness of instructional approaches and the possible influence of gender. Nkepah (2022) found that students taught indices using the inductive method performed better than those taught using the deductive method. The study also reported different gender patterns: female students performed better under inductive instruction, whereas male students performed better under deductive instruction. In contrast, Okigbo and Nwigboji (2025) found that the inducto-deductive approach improved early numerical achievement compared with the expository method, with no significant difference between male and female students. These findings suggest that gender-related achievement patterns may vary according to the instructional approach and mathematical content. However, the reported differences should not be interpreted as evidence of inherent gender-based learning abilities. Further research is needed to establish whether gender moderates the relationship between teaching methods and mathematics achievement. These studies provide evidence supporting the use of learner-centred and reasoning-oriented instructional approaches in mathematics, but they do not establish a consistent advantage for one approach across all outcomes and contexts. Rajni (2018) found comparable outcomes for inductive and deductive methods, whereas Iyanda and Sam-Kayode (2024) and Nkepah (2022) reported advantages for different methods. Similarly, Imam et al. (2018) reported positive outcomes for the combined approach, while Rahmah (2017) found no significant advantage over conventional teaching. These differences make it important to investigate the impact of inducto-dedcutive approach within specific educational settings and for clearly defined mathematical concepts.

The reviewed of empirical studies indicate that inductive, deductive and inducto-deductive methods can contribute to mathematics learning, although their reported effects differ across studies. Some researchers found that both inductive and deductive methods improved achievement compared with conventional instruction, while others reported an advantage for one approach over another. Evidence concerning the inducto-deductive approach is also mixed, particularly in relation to mathematical problem-solving. Furthermore, the reported findings on gender do not demonstrate a consistent pattern across the studies. Consequently, the literature provides a basis for further investigation but leaves unresolved questions about the comparative effectiveness of these approaches in specific contexts. A study that directly examines the instructional approaches using a clearly defined student population, mathematical content and common achievement measures could help address these uncertainties.

3 Theoretical Framework

Bruner’s Theory of Discovery Learning emerged from the cognitive revolution in psychology during the 1950s and 1960s. Jerome Seymour Bruner was one of the major scholars who challenged the dominant behaviorists view that learning could primarily be explained through observable changes in behavior produced by reinforcement. His early work on thinking and categorization contributed to the development of cognitive psychology. Bruner's work was also closely associated with the development of curriculum and inquiry-oriented approaches to science education. In 1959, he became involved in an influential National Research Council committee examining new science curricula in the United States. This experience contributed to his argument that learners should not merely memorize isolated scientific facts but should develop an understanding of the underlying structures and relationships within academic disciplines.

Central assumption of Bruner’s theory is that learners are not passive recipients of information. They actively organize information, identify relationships, generate hypotheses and construct meaning from their experiences. Bruner therefore places considerable importance on intellectual activity during learning. For mathematics education, this means that students should have opportunities to investigate mathematical relationships rather than simply memorize formulas presented by the teacher. Bruner proposed three complementary modes of representing knowledge:

1. Enactive representation – learning through actions or manipulation.
2. Iconic representation – learning through images, diagrams and visual representations.
3. Symbolic representation – learning through language, mathematical symbols and abstract notation.

Bruner's ideas have had considerable influence on science education because scientific learning naturally involves observation, questioning, investigation, evidence, explanation and generalization. Modern discussions of Bruner's discovery learning continue to position it within science education and inquiry-oriented teaching in Mathematics. Through guided exploration, students are expected to develop an understanding of the concept rather than merely memorize a formula. In Arithmetic Progression, this includes understanding:

a. the first term;

b. common difference;

c. general term;

d. relationship between terms;

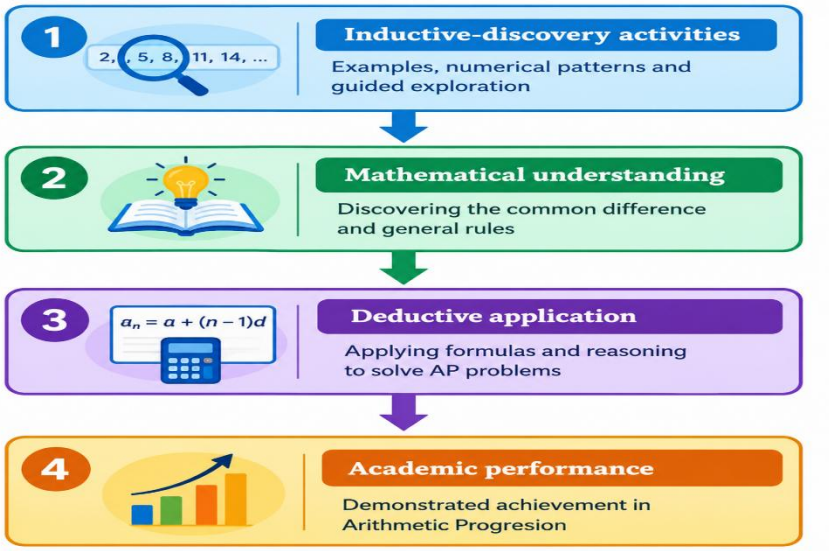
e. sum of terms; and

f. application of these relationships to mathematical problems.

Consequently, the effectiveness of discovery-oriented instruction depends not simply on presenting examples, but also on how the teacher structures the learning experiences and supports students' reasoning.

Figure **1**

Bruner's Discovery Learning Framework

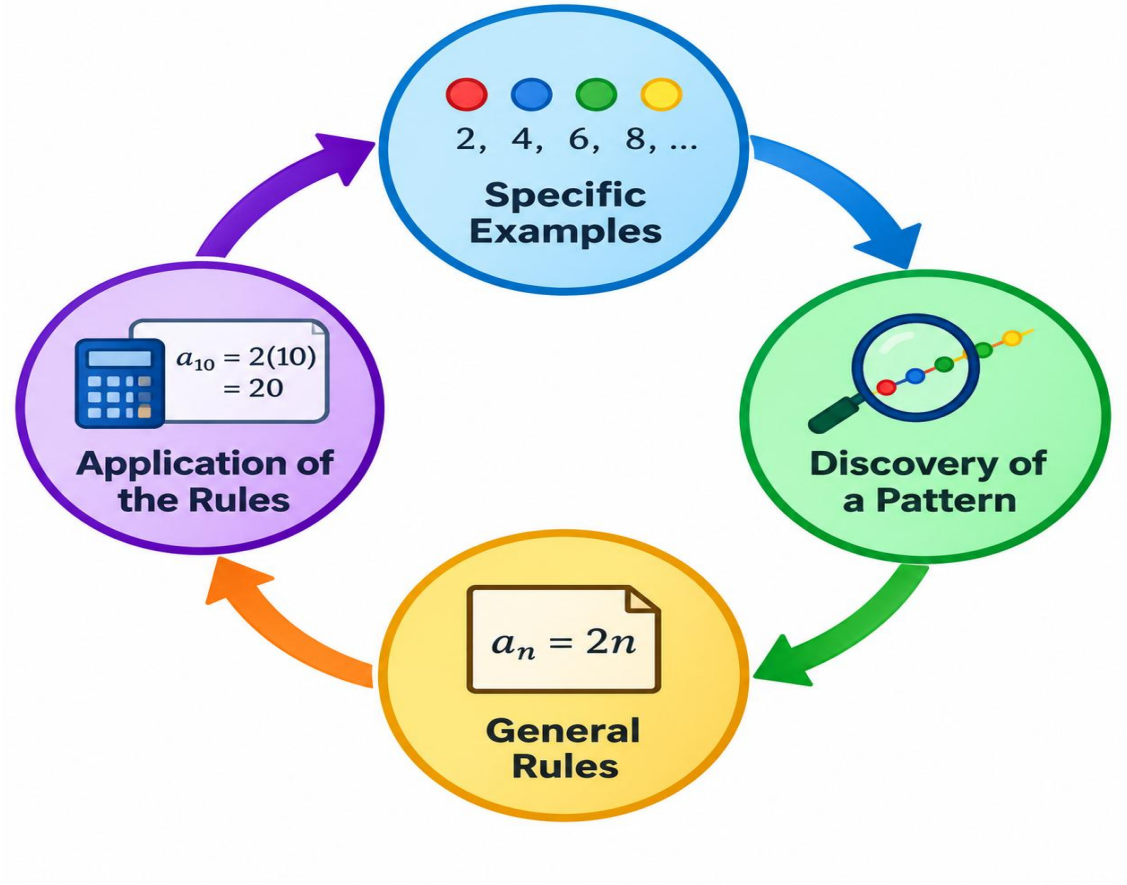


Teaching Arithmetic Progression using Inducto-Deductive Approach

The inducto-deductive approach combines both inductive and deductive approaches to teach a concept. Where the inductive approach ends by generating the general rules or formula, the deductive approach starts to test other specific examples.

Figure 2

Inducto-Deductive Steps



From Figure 2, the inductive approach starts with many specific examples. Through that, the students discover a pattern on how such examples were solved. Then, from the pattern, students may be able to make generalizations either by drawing general rules or developing a formula. At this point, the deductive approach starts. Using the general rules or formula generated in the inductive stage. Students will go further to see whether the formula holds for any specific values.

4 Materials and Methods

The study employed a pre-test–post-test non-equivalent control-group quasi-experimental design. The population of the study comprised 4,021 students drawn from 15 secondary schools in Zaria Metropolis, consisting of 2,574 male and 1,447 female students. Two secondary schools were selected from the 15 schools using a simple random sampling technique through balloting. The selected schools were assigned to the experimental and control group. The experimental group comprised 93 students, consisting of 61 males and 32 females, while the control group comprised 91 students, consisting of 53 males and 38 females. Prior to the intervention, the students in both groups were administered a pre-test to determine their initial level of performance in Arithmetic Progression. The experimental group was subsequently taught Arithmetic Progression using the inducto-deductive instructional approach, while the control group was taught the same content using the conventional instructional method. The intervention lasted for six weeks, with both groups receiving instruction for the same duration and covering the same prescribed content and learning objectives. The instructional procedures for both groups were guided by prepared lesson plans. To enhance treatment fidelity, one of the researchers implemented the instructional treatment while another researcher independently monitored the instructional sessions using the prescribed lesson plans and procedures. This procedure was intended to ensure that the instructional treatments were implemented consistently throughout the intervention period.

Following the six-week intervention, the students were administered the post-test using the Arithmetic Progression Performance Test (APPT). The APPT consisted of 10 essay-type questions, with each question carrying 10 marks, giving

a maximum possible score of 100 marks. The marking scheme specified the allocation of marks to the relevant mathematical procedures and the correctness of the final answers in order to promote consistency in scoring. The content validity of the APPT was established through expert review. The instrument was examined by four experienced secondary-school Mathematics teachers who possessed at least a bachelor's degree and had relevant experience in Mathematics teaching. The experts assessed the items in relation to their relevance to the content of Arithmetic Progression, clarity, appropriateness, and alignment with the objectives of the study. Their observations and recommendations were used to revise the instrument before its administration.

A pilot test of the APPT was conducted among 32 students in a secondary school within the study population but outside the schools selected for the main study. The pilot exercise was conducted to ascertain the suitability of the test items, the clarity of the instructions, the appropriateness of the scoring procedure, and the reliability of the instrument. The test scores were initially divided into two comparable halves, and the Pearson Product-Moment Correlation coefficient was used to determine the correlation between the two halves. A correlation coefficient of 0.76 was obtained. The Spearman–Brown prophecy formula was subsequently applied to estimate the reliability of the full-length test, yielding a coefficient of 0.86. This coefficient indicated satisfactory internal consistency of the test (Feldt & Charter, 2003). Because the APPT consisted of essay-type items, inter-rater reliability was established by having three independent qualified raters score the same scripts using the standardized marking scheme. There rating was subjected to analysis using Intraclass Correlation Coefficient (ICC) and the coefficient was found to be 0.89. ICC was calculated at 95% confidence interval using Jamovi based on a mean-rating (2, 3), 2-way random effects model, absolute-agreement. This shows a good agreement. According to Koo and Li (2016) ICC values less than 0.5 are indicative of poor reliability, values between 0.5 and 0.75 indicate moderate reliability, values between 0.75 and 0.9 indicate good reliability, and values greater than 0.90 indicate excellent reliability.

The data collected were analyzed using both descriptive and inferential statistics. Means and standard deviations were used to summarize students' performance and address the research questions, while Analysis of Covariance (ANCOVA) was employed to test the null hypotheses at the 0.05 level of significance. Pre-test scores were used as the covariate to statistically account for initial differences in students' performance before the intervention. Prior to conducting ANCOVA, the relevant assumptions were examined. The normality of the ANCOVA residuals was assessed using the Shapiro–Wilk test and the associated Q–Q plot. The result indicated no statistically significant departure from normality, $= 0.991, p = .192$. The assumption of homogeneity of variance was assessed using Levene's test, which was not statistically significant, $(1, 180) = 2.86, p = .360$, indicating no statistically significant evidence of unequal variances among the groups. The linearity assumption was assessed by examining scatterplots of pre-test and post-test scores separately for the instructional groups. The plots indicated an approximately linear relationship between the pre-test and the post-test. In addition, the assumption of homogeneity of regression slopes was examined by testing the interaction between instructional group and pretest scores. The Group × Pretest interaction was not statistically significant, F (1, 180) = 9.28, p = .394. This indicates that the relationship between pretest and posttest scores did not differ significantly between the experimental and control groups. Therefore, the assumption of homogeneity of regression slopes was considered satisfied, and ANCOVA was deemed appropriate for comparing the adjusted posttest means of the two groups.

5 Results

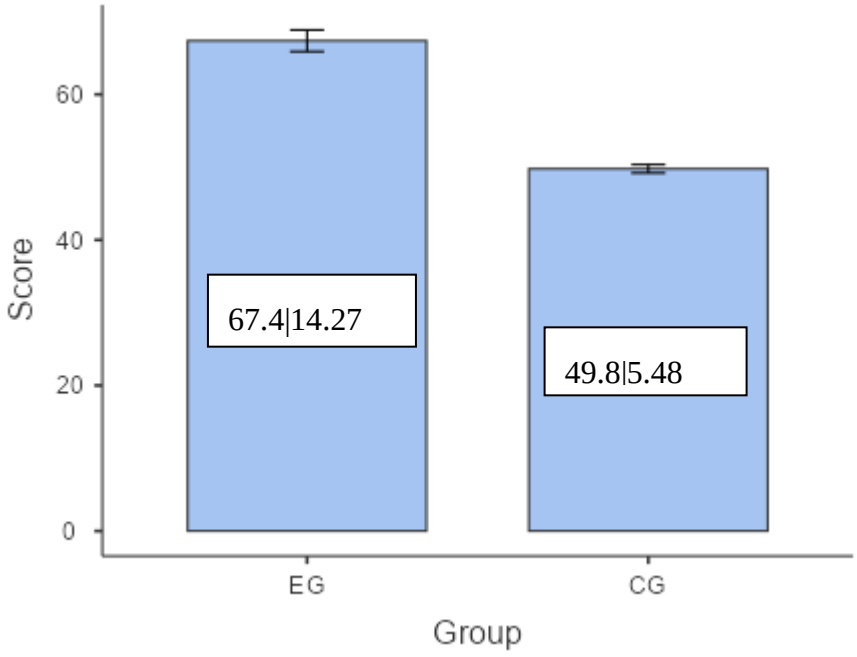
The data collected using APPT were subjected to analysis using the Jamovi statistical software package. The research questions were addressed using figures, while the null hypotheses were tested using ANCOVA at a 0.05 level of statistical significance.

5.1 Research Question one

To address this research question, descriptive statistics were used. The results are presented below.

Figure **3**

Descriptive Statistics of Experimental and Control Group



From Figure 2, the mean and standard deviation of the experimental group are 67.4 and 14.27, respectively. The mean and standard deviation of the control group are 49.8 and 5.48, respectively. The mean difference between the experimental and control groups is 17.6. However, this mean difference led the researcher to test whether the difference is statistically significant.

To test whether the mean difference between the experimental and control group ANCOVA was used at the 0.05 level of statistical significance. The results are shown in Table 1 below.

Table 1: ANCOVA Result of Experimental and Control Group

	Sum of Squares	**df**	**Mean Square**	**F**	**p**	**η^2p**
Overall model	14118.5	2	7059.2	59.312	<.001	
Group	14085.2	1	14085.2	118.571	<.001	0.397
Pre-test	33.3	1	33.3	0.280	0.597	0.002
Residuals	21382.4	180	118.8			

The result in Table 1 shows that there was a statistically significant difference between the experimental and control groups, $F(1, 180) = 118.571$, $p < .001$. Since the p-value is less than the 0.05 significance level, the null hypothesis stating that there is no significant difference in the mean academic performance of students in the experimental and control groups is rejected.

The effect size, $\eta^2 = 0.397$, indicates that approximately 39.7% of the variance in students' post-test academic performance associated with group is due to the teaching method, after controlling for pre-test performance. This represents a large effect.

In contrast, the covariate (pre-test score) was not statistically significant, $F(1, 180) = 0.280$, $p = .597$, indicating that pre-test scores did not significantly predict post-test performance in the study.

5.2 Research Question two

Figure **4**

Descriptive Statistics of Male and Female in Experimental Group

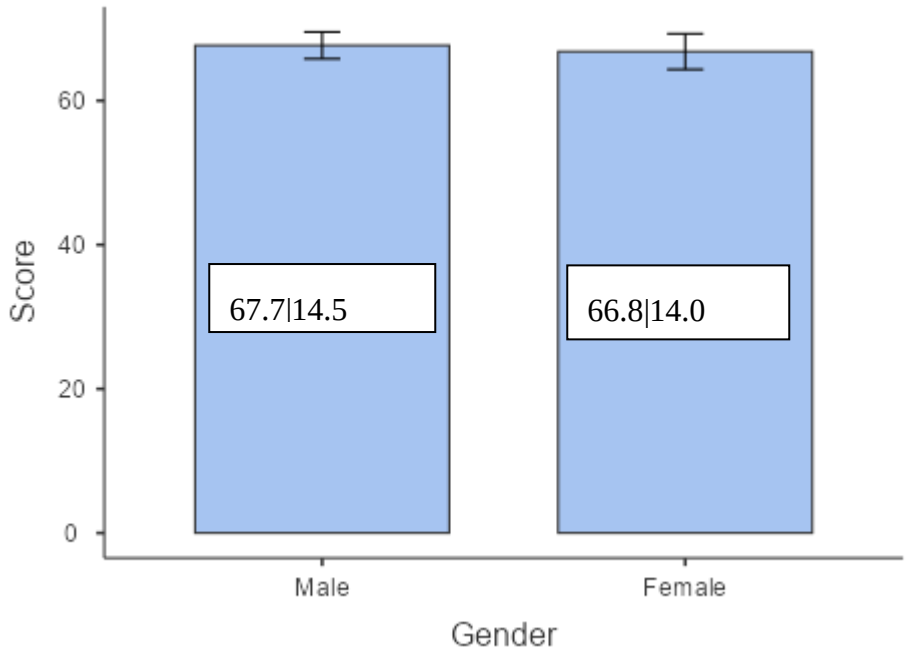


Figure 3 shows the mean and standard deviation of male and female students taught Arithmetic Progression using the Inducto-Deductive approach. Males have a mean and standard deviation of 67.7 and 14.5, respectively. Females have a mean and standard deviation of 66.8 and 14.0, respectively. The mean difference between male and female students taught AP using the Inducto-Deductive approach is 0.9.

To test whether this difference is significant, the researcher used ANCOVA by embedding pre-test as a covariate at the 0.05 level of statistical significance. The result is shown in Table 2.

Table **2**

ANCOVA result of Male and Female Students in Experimental Group

	Sum of Squares	**df**	**Mean Square**	**F**	**p**	**η^2p**
Overall model	38.0	2	19.0	0.0974	0.907	
Gender	13.0	1	13.0	0.0625	0.803	0.001
Pre-test	25.0	1	25.0	0.1201	0.730	0.001
Residuals	18701.4	90	207.8			

The result in Table 2 indicates that there was no statistically significant difference between male and female students' post-test academic performance, $F(1, 90) = 0.0625$, $p = .803$. Since the p-value (.803) is greater than the 0.05 significance level, the null hypothesis that there is no significant difference in the academic performance of male and female students taught AP using the inducto-deductive approach is not rejected. The effect size was $\eta^2 = .001$, indicating that gender accounted for only approximately 0.1% of the variance in post-test academic performance. This represents a negligible effect, suggesting that gender had practically little influence on students' academic performance under the inducto-deductive approach. Furthermore, the pre-test covariate was not statistically significant, $F(1, 90) = 0.1201$, $p = .730$, indicating that the students' pre-test performance did not significantly influence their post-test performance after accounting for gender.

6 Discussion

The first finding revealed a statistically significant difference in the post-test academic performance of students in the experimental and control groups, after controlling for their pre-test scores. The magnitude of the effect is substantial, with the instructional group accounting for approximately 39.7% of the variance in students' post-test performance. The finding suggests that the inducto-deductive approach produced a meaningful difference in students' performance beyond what could be attributed to their initial level of performance. The non-significant effect of the pre-test score further indicates that the observed difference between the groups was not significantly associated with students' initial performance levels. The finding is consistent with recent evidence that inductive and deductive approaches can enhance mathematics performance. Iyanda and Sam-Kayode (2024) investigated inductive and deductive teaching strategies among students in Nigerian Colleges of Education and found a significant treatment effect on Basic General Mathematics achievement. Their result showed that students exposed to the inductive and deductive approaches performed significantly better than those taught through the conventional approach. Although their study reported that the deductive group performed better than the inductive group, the broader finding supports the present result that moving away from conventional instruction toward more structured active approaches can improve mathematics learning. Similarly, Rajni (2018) reported a significant effect of deductive and inductive teaching strategies on students' achievement in Further Mathematics and found that inductive and deductive teaching strategies are better than the traditional teaching method. Furthermore, Nkepah, (2022) in his research to compare the effectiveness of inductive and deductive teaching of indices in secondary schools found that students performed better when they were taught the indices concept using the inductive method than when taught using the deductive method.

The second finding revealed that there was no statistically significant difference between the academic performance of male and female students taught AP using the inducto-deductive approach, after controlling for pre-test performance. The extremely small effect size indicates that gender accounted for only about 0.1% of the variance in students' post-test performance. The result therefore suggests that male and female students benefited from the inductive-deductive approach in broadly comparable ways. This finding is supported by Okigbo and Nwigboji (2025), in their study to check

the effect of the inductive-deductive approach on children's early numerical achievement in mathematics, found no significant difference between male and female students taught numerical concepts using the inductive-deductive approach. Furthermore, Nkepah (2022), in his research to compare the effectiveness of inductive and deductive teaching of indices in secondary schools, found that female students performed better than their male counterparts when taught indices using the inductive method. In addition, Shafi et al. (2022), in their study to check the effect of inductive learning strategy on students' academic performance, found no significant difference in the academic performance between male and female students. This implies that the inductive learning strategy is gender-friendly

7 Conclusion

Based on the findings, it is concluded that the inducto-deductive approach significantly enhanced students' academic performance in Arithmetic Progression compared with the conventional teaching approach. Furthermore, male and female students taught using the inducto-deductive approach performed comparably, indicating that the approach was effective without significant gender-related differences in performance. Therefore, the findings suggest that the inducto-deductive approach is an effective and gender-inclusive strategy for improving students' learning of Arithmetic Progression.

8 Limitations of the Study

The study was subject to some limitations that should be considered when interpreting its findings. First, there was an unequal distribution of male and female students across the experimental and control groups. This gender imbalance may limit the extent to which the findings represent both genders equally. Second, the study involved only two schools, with one school serving as the experimental group and the other as the control group. Thus, differences attributable to school characteristics cannot be completely separated from the effect of the instructional approach. Consequently, caution should be exercised in generalizing the findings beyond the participating schools. However, efforts were made to minimize these limitations by using the same researcher, comparable instructional content and duration, standardized lesson plans, and consistent assessment procedures for both groups.

9 Recommendations

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

1. Mathematics teachers should adopt the inducto-deductive approach when teaching Arithmetic Progression. Teachers should guide students to observe patterns, identify relationships and formulate general rules before helping them apply those rules to solve mathematical problems.
2. Mathematics teacher educators should incorporate the inducto-deductive approach into teacher-training programmes. Workshops, micro-teaching sessions and practical demonstrations should be organized to equip pre-service and practicing teachers with the skills needed to effectively implement the approach.
3. Schools should provide simple instructional materials that support inducto-deductive teaching. Teachers can make use of number sequences, charts, worksheets, locally available materials, and real-life examples to enable students to discover mathematical patterns before formalizing the underlying principles.
4. Teachers should provide equal learning opportunities for male and female students when using the inducto-deductive approach. Since the study found no significant gender difference in performance, teachers should avoid gender-based assumptions about students' mathematical abilities and ensure that both male and female students participate equally in classroom discussions, problem-solving activities, and practical tasks.

10 Declarations

Conflict of Interest: The authors declare neither financial nor non-financial conflict of interest.

Author Contributions: All the authors contributed to this research, and they are liable for any information provided

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