

Effect of Differentiated Instruction on Achievement in Mathematics among Pupils in Basic Schools in Federal Capital Territory, Abuja, Nigeria

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ABSTRACT

This study examined the effect of differentiated instruction on pupils' achievement in Mathematics in Basic Schools in the Federal Capital Territory, Abuja, Nigeria. Two (2) research questions were formulated to guide this study. Two (2) null hypotheses were also stated and tested at a 0.05 level of significance. The research design employed was the Quasi-experimental design. The population for this study is 21,959 pupils. A sample size of 127 pupils was purposively selected. The instrument employed in this study for data collection was the Mathematics Achievement Test (MAT) to evaluate pupils' achievement in mathematics. The face and content validity of the instrument was established by consulting three experts. The reliability of the instrument was determined by using the test-re-test method of reliability, following a pilot test. The Kuder Richardson (KR-21) reliability test for the Mathematics Achievement Test yielded 0.84 indicating they were reliable for collecting data for this study. The data collection procedure involved the distribution of the instruments to the pupils, using research assistants for pre-tests, to know the entry point of the pupils. A post-test after seven weeks of treatment was conducted to evaluate their achievement. The research questions were analyzed using statistical mean scores and standard deviations. The ANCOVA and t-test were used to test hypotheses. The results showed that differentiated instruction had a positive effect as there was a significant improvement in the pupils' achievement after the intervention with differentiated Instruction. The researchers recommended that teachers should use differentiated instruction methods of teaching to improve the pupils' achievement in mathematics.

Keywords: Effect, differentiated, instruction, achievement, challenges

Introduction

Education is instrumental to the development of man in all ramifications. The high value placed on education is because of the organized structure through which knowledge is passed from generation to generation, as well as the relevance of such knowledge in building/advancing human societies. The importance of education at all levels and in all ramifications, cannot be over-emphasized. The value of education in the development of human personality, thoughts, and social skills is undisputed. It

prepares people for life experiences. It designates and places man at a special social status in our society. Education polishes our minds, reinforces our thoughts, and strengthens our character and behaviors toward others. It equips us with information in various fields in general and in our areas of specialization. Thus, education can be viewed as the process of acquiring knowledge and information that leads to a successful future. The Basic school is the foundation where special rudiments in education are laid before higher contents are added. At this level, teachers are challenged with different learning difficulties since learners are of different categories and learn differently at unique paces. The concern of 21st-century teachers especially in Basic schools in Nigeria is the capacity to deal with different learning challenges among pupils in the same classroom.

There are different types of learners with different learning needs and achievement levels. The expectation of the school and parents is that the teacher should be able to attend to all pupils, irrespective of their learning problems. According to Ojonugwa (2018), one of the greatest challenges of teachers in the twenty-first century is coping with the learning needs of pupils with different achievement levels in the same classrooms. Pupils learn in different ways and at their paces. With pupils of different learning styles ranging from visual, auditory, reading and writing, and kinesthetic in the classroom. The use of a conventional method of teaching may be inadequate to take care of the learning needs of the different types of learners. This is especially true in Basic school. Ojonugwa (2018) argued that the use of a traditional method of teaching which does not create room for activity-based learning may hinder the learner's attitude and achievement, especially in mathematics among Basic school pupils. This may result in poor performance in mathematics.

Traditional teaching strategies have been adjudged as not having the capacity to meet the learning needs of the 21st-century classroom. Present-day classrooms engage innovative teaching strategies such as differentiated instruction, collaborative strategy, flipped classroom, blended learning, and activity-based practices. Other examples of activity-based learning according to Dimitrios, Labros, Nikolaos, Maria, and Athanasios (2013) are information and communication technologies, the Internet as well as various computer programs, simulations, and case studies on real and virtual work environments. The above activity-based learning strategies have different concepts when compared with the traditional method of teaching. One of the teaching strategies that may deal with different learning challenges in school is differentiated instruction.

Differentiated instruction (DI) is a teaching strategy that provides learners with assorted teaching

strategies that are considered appropriate to resolve the learning challenges of different learners in the same classroom. The above strategy requires the teacher to teach independently and sometimes make use of small groups and employ other teaching strategies to enhance teaching and learning. According to Karadag and Yasar (2010), differentiated instruction is a kind of teaching approach based on the understanding that pupils have individual differences in terms of teaching interests, skills, learning styles, and learning needs. Differentiated instruction is a forward-looking approach, based on evaluation, multidimensional for the content, process, and product, pupil-centered, and a mixture of large, small group, and individual teaching.

Differentiated instruction gives the teacher the liberty to employ diverse teaching techniques to get pupils to learn concepts, ideas, and learning experiences to enhance effective learning. In many Basic schools in the Federal Capital Territory, mathematics teachers are overwhelmed with the requirements of their job and lack the necessary skills to incorporate differentiated instruction methods during their classroom teaching. Most of these teachers usually use lecture and discussion methods in teaching their pupils, which is inadequate for their level. The lecture method, which is a one-way medium for the transmission of information in the classroom, enables the teacher to do the teaching while pupils are passive. This method is characterized by less pupil participation and involvement during classroom lessons. They are expected to combine information and organize it for their consumption. The lecture method is mostly used in higher institutions of learning, which is adequate based on the level of the learners. The discussion method is more of a rational teaching method that encourages a conducive classroom atmosphere where sharing of ideas, promoting tolerance, and allowing pupils to express their opinions and views on diverse classroom issues. This method is equally not suitable for basic school learners, since their level of understanding and thinking could not be said to be rational. Rather, this method could be more suitable for pupils in secondary schools and higher institutions based on their levels of reasoning. All these have laid the foundation for the indifference to pupils' interest and poor attitude in mathematics, hence, poor achievement rate in mathematics of pupils in various Basic schools in the FCT.

Ojonugwa (2018) portrayed differentiated instruction as a teaching strategy with different teaching techniques designed to assist learners at different learning paces in the same class. Differentiated instruction methods provide teachers with diverse strategies during the teaching and learning process to assist learners in meeting their goals in the classroom which could bring about individual academic

success. They use specific strategies such as individual learning, computer learning, stimulation of senses, varied homework, peer helping, questioning, and open-ended projects amongst others. Differentiated instruction is one of the teaching methods that if properly implemented, may lead to an improvement in the achievement of pupils in schools (Kalpana, 2014).

Differentiated instruction has been reported to improve the interest, attitude, and achievement of different learners. According to Kalpana (2014), differentiated instruction is a teaching strategy that emphasizes the careful study of learners' differences in achievement and the implementation of appropriate techniques capable of improving their achievement, particularly in mathematics. In addition, Shumba and Awoniyi (2014) opined that differentiated instruction is a strategy of teaching that requires the teacher to have full academic achievement knowledge including the learning needs of all pupils in their classroom. Differentiated instruction is therefore meant to observe and understand the differences and similarities among pupils and use this information to plan instruction. Differentiated instruction has the interest, achievement, readiness, background, and pupil's learning problem at the centre of learning. In agreement with the above idea, Tomlinson (2015) asserted that differentiated instruction is tailoring learning instruction to meet the learning needs of individuals such as boosting the achievement of Basic school pupils in multiplication and division of numbers in mathematics. This can be achieved through the use of strategies like learning stations, interest centres, teach-up, task boards, and open-ended projects.”

In this study, differentiated instruction is a teaching strategy that uses activity-based and other teaching strategies in teaching educational concepts and learning experiences to meet the needs and learning challenges of the learners. Some strategies are individualized teaching, peer collaboration, activity room, work, and task board, varied and capacity-based assignments, teaching aids learning stations. Guided personal study time, assisted teaching, and activity projects to meet the learning needs of learners of different learning achievement levels in the same classroom. Differentiated instruction with its interactive nature and activity-based structures could activate and motivate the interest and attitude of pupils in FCT, Basic schools.

Achievement is the learning outcome of learning activities which comes in the form of grading and feedback in grade form as measured by continuous assessment, test, and examination. According to Khurshid and Abbas (2013), achievement is the learning outcome obtained after tests, assignments, and examinations generated from the school curriculum, and scheme of work. Olusanjo (2013) opined

that achievement is scores generated for response to questions presented to the pupil through continuous assessment, tests, examinations, and other measuring tools for promotion and placement in school and society. Ojonugwa (2018) noted that the outcome of the examination and assessment revealed the levels of achievement of the pre-stated learning objectives. He also noted the levels of learning and change in behavior that took place in the learners after they had been exposed to learning activities, projects, assignments, and homework with formative and summative evaluation.

Gender differences in students' learning have been debated by researchers over the years. Chadwell (2010) argued that boys and girls see, hear, and engage in the learning process very differently. It is obvious, however, that all students benefit from a variety of methods, gender notwithstanding. When equity is observed in the learning environment, both boys and girls may be capable of developing talent, skills, and interest at equal rates. Based on this idea, there was a need to probe the effect of differentiated instruction on student's achievement in mathematics by gender.

The implementation of the 9-Year Basic Education Curriculum, according to Obioma (2012), was developed for the attainment of Education for All (EFA) goals, the critical targets of the National Economic Empowerment and Development Strategies (NEEDS) and the Millennium Development Goals (MDGs). It commenced nationwide in September 2008 in primary one and Junior Secondary one (JSS 1) respectively. The Curriculum produced its first batch of JSS graduates in 2011 and the first set of beneficiaries at the Primary school level entered the Junior Secondary Schools in 2014.

The philosophy of the 9-year Basic Education Curriculum is centred on the understanding that every learner who has gone through the 9 years of basic education should have acquired appropriate levels of literacy, numeracy, manipulation, communication, and life skills. As well as the ethical, moral, and civic values required for laying a solid foundation for life-long learning as a basis for scientific and reflective thinking. It is pertinent to highlight the three components of the curriculum according to the corresponding levels and the age of the pupils and pupils from primary 1-3, 4-6, and JS 1-3.

The 9 years Basic Education Curriculum (Basic 1-9) has three components, namely:

- Lower Basic Education Curriculum for Primary 1-3 (age 6-8 years)
- Middle Basic Education Curriculum for Primary 4-6 (age 9-11)
- Upper Basic Education Curriculum of Junior Secondary School (JSS) 1-3 (age 12-14)

Basic education is the elementary part of education, on which the contents of other levels are built. The goals of this level of education as enumerated by the Federal Republic of Nigeria (FRN) in the

National Policy on Education are to: inculcate permanent literacy and numeracy, and the ability to communicate effectively, lay a sound basis for scientific and reflective thinking, give citizenship education as a basis for effective participation in and contribution to the life of the society, mold the character and develop sound attitude and morals in the child, develop in the child ability to adapt to the child's changing environment, give the child opportunities for developing manipulative skills that will enable the child to function effectively in the society within the limits of the child's capacity and provide the child with basic tools for further educational advancement, including preparation for trades and craft of the locality.

Based on the identified problems of low achievement in mathematics in Abuja, Nigeria's Federal Capital Territory, the need for innovative methods such as differentiated instruction that can improve achievement in basic school mathematics becomes inevitable. Hence, an investigation into the effect of differentiated instruction is identified as a viable, innovative teaching strategy in this study.

The following research questions guided the study:

- i. What is the mean achievement score of primary school pupils in mathematics before and after exposure to differentiated instruction and traditional methods in Bwari Area Council?
- ii. What is the difference in male and female pupils' academic achievement in mathematics when taught with differentiated instruction?

The following null hypotheses were formulated and tested at a 0.05 level of significance.

H₀₁: There is no significant difference between the post-test achievements in mathematics when pupils are taught with differentiated instruction and traditional lecture methods.

H₀₂: There is no significant difference between male and female pupils' achievement in mathematics when taught with differentiated instruction.

METHODOLOGY

Research Design

This research adopted a quasi-experimental design. It was a pretest, post-test non-randomized control group design. This design, according to Akinbobola, Ikitde, Nkwo & Nkwo, (2016) is used when there is non-randomization of research subjects.

This design was adopted because the researchers were unable to randomly select the subjects and assign them to groups, thus intact classes were involved in the study. The design was considered appropriate for this study because it allowed the researchers to compare the two groups; pre-test and

post-test scores without disturbing the class setting and enabling the researchers to determine treatment effects.

The quasi-experimental design allowed the researchers to repeat the test after the completion of the experiment. The instructional strategy was at two levels (experimental and control groups), while the test level was at two (pre-test and post-test). This approach gave insight into the effects of Differentiated Instruction on pupils' interest, attitude, and academic achievement in Mathematics.

Population of the Study

The population of the study consisted of 2022/2023 Basic IV pupils in Bwari Area Council of the F.C.T numbering 21,959. A further breakdown of the population indicated that there were 12,388 male and 9,571 female pupils (Bwari Area Council Education Office, 2023).

Sample Size and Sampling Procedure

The total sample size comprised 127 pupils. 62 pupils (37 males and 25 females) were in the experimental group, which was taught with differentiated instruction, while the second school was the control group with 65 pupils (35 males and 30 females) which were taught with the traditional method. This was in line with Fraenkel and Wallen (2011) who recommended at least 30 pupils per group. Hence, the number was considered adequate for the study. A purposive sampling technique was used to select two schools in Bwari Area Council. Public basic schools were used because of the decline in mathematics achievement. The study used public-owned primary schools that have been in existence for over ten years and presented pupils for BECE consecutively over five years.

A simple random sampling technique, using balloting without replacement, was used to select two intact classes from the public primary schools of mixed gender in the study area. Intact classes in both schools used for the study (experimental and control) were scrutinized to ensure that any chosen class in each school had an equal entry level in the pre-test. Gender was included to check the gender bias in both groups.

Instrumentation

The instrument used in collecting the data for the study was the Mathematics Achievement Test (MAT). The Kuder Richardson (KR-21) was used to test for the reliability of MAT and the index was 0.84.

Experimental Procedure

Before the commencement of the research work, the researchers collected a letter of introduction from the Head of the Department to seek the cooperation of the schools involved. The researchers explained the purpose of the study and the benefits that would be derived if properly conducted.

The researchers with the aid of research assistants, who were initially briefed on the nature of the study and how to go about the data collection process, administered the instruments. During the actual research work, the pupils in the treatment and control groups were pre-tested with the instruments before commencing the treatment. The treatment involved teaching the experimental group using Differentiated Instruction (DI) as summarized below.

Week 1 Orientation and Pre-test using Mathematics Achievement Test (MAT).

Week 2 The use of collaborative and teach-up strategies to teach multiplication of two-digit numbers by 1-digit numbers in unit one and 3 by 1-digit numbers in unit two.

Week 3 The researchers used a learning station, task board, and free study time in teaching multiplication of 2 by 2-digit numbers in unit 3, and collaborative, worksheet, and individualized coaching strategies were used in teaching multiplication of 3 by 3-digit numbers in unit 4.

Week 4 Collaborative and questioning will be used in teaching multiplication of factors of numbers and collaborative, task board, and teach-up in teaching word problems in multiplication in unit 6.

Week 5 Discussion, learning station, and teach up in the class interaction with the teacher in teaching division of 2-digit numbers without remainder in unit 7 and collaborative, questioning, and individualized coaching strategies in teaching 3-digit numbers without remainder in unit 8.

Week 6 Collaborative, Independent work, and individualized feedback strategies in a division of 3-digit numbers with remainder and collaborative, questioning, and free study time strategies for word problems in the division of numbers for units 9 and 10 respectively.

Week 7 Administration of Mathematics Achievement Test (MAT) as post-test.

The control group was taught using the conventional method, as each lesson lasted for 40 minutes.

Method of Data Analysis

The pre-test and post-test data obtained from the administration of the Mathematics Achievement Test was analyzed using mean and standard deviations for research questions. ANCOVA and t-tests were used to test the hypotheses. ANCOVA is appropriate for tests where the pretest is used as a covariate while a t-test was used to determine significant differences between the two groups based on the mean scores. All the hypotheses were tested at a 0.05 level of significance.

Results

Research Question One: What is the mean achievement score of primary school pupils in mathematics before and after exposure to differentiated instruction and traditional methods in Bwari Area Council?

Table 1: Pre-Test and Post-Test Mathematics Achievement Mean and Standard Deviation Results of Experimental and Control Groups

Group	Pre-Test			Post-Test		
	Mean	SD	Remark	Mean	SD	Remark
Experimental	16.08	4.75	Low	29.47	6.09	High
Control	15.75	4.68	Low	22.92	5.23	Low

Table 1 revealed the mean and standard deviation results of the pre and post-mathematics achievement of the experimental and control groups. The result for the experimental group yielded a mean of 16.08 before treatment, indicating low achievement in mathematics among the pupils. After treatment, the results for the experimental group yielded a higher mean score of 29.47 than the control group with 22.92. It indicated that those exposed to differentiated instruction had high achievement in mathematics, while those exposed to traditional methods had low achievement.

H_{01} : There is no significant difference between the post-test achievements in mathematics when pupils are taught with differentiated instruction and traditional methods.

Table 2: Summary of ANCOVA Results of Post-Achievement of Pupils in the Experimental and Control Groups

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
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Corrected Model	4534.764a	2	2267.382	336.929	.000	0.845
Intercept	848.89	1	848.89	126.144	.000	0.504
Pre-test	3175.586	1	3175.586	471.887	.000	0.792
Group	1216.408	1	1216.408	180.756	.000	0.593
Error	834.465	124	6.73			
Total	92003	127				
Corrected Total	5369.228	126				

a. R Squared = .845 (Adjusted R Squared = .842)

Table 2 shows the Analysis of Covariance comparing the post-test mean achievement of pupils taught Mathematics using differentiated instructions and traditional methods while controlling for covariance (pre-test). There was a significant difference in the mean achievement between the experimental and control groups with $F(1, 124) = 180.756, p = 0.000$. The null hypothesis was therefore rejected.

The study found that differentiated instructions have a positive (significant) effect on the post-test achievement of pupils when the covariant effect (pre-test) was controlled. This result revealed that the application of differentiated instructions in the teaching of mathematics accounted for the difference in post-test mean achievement of the pupils.

Ho2: There is no significant difference between males and females in the post-test achievement of pupils in mathematics in basic schools in F.C.T, Abuja, Nigeria.

Table 3: t-test on the Difference between Male and Female Pupils' Achievement in Mathematics taught using Differentiated Instruction

Gender	n	Mean	S. D	t-value	df	Sig(2-tailed)	Decision
Male	37	29.24	6.58	-.351	60	.727	Not
Female	25	29.80	5.39				Significant

Table 3 shows the difference between males and females in the post-test achievement of pupils in mathematics in basic schools in F.C.T, Abuja, Nigeria. With the significant values of .727 (greater than the 0.05 level of significance), the hypothesis that says that there is no significant difference between males and females in the post-test achievement of pupils in mathematics in basic schools in F.C.T, Abuja, Nigeria is therefore, accepted. It was concluded that male and female pupils taught using

differentiated instruction did not differ significantly in mathematics achievement in basic schools in F.C.T, Abuja, Nigeria.

Discussion of Findings

This study identified improvement in the pupil's achievement after they were taught with differentiated instruction in mathematics in basic schools in FCT, Abuja, Nigeria. The study found that differentiated instruction had a statistically significant effect on post-test mean achievement of pupils in mathematics in basic schools in FCT, Abuja, Nigeria. This agrees with Koeze (2007), who observed that a differentiated instruction approach led to higher student achievement than other methods. It is also similar to a study conducted by Aranda and Zamora (2017) which revealed that differentiated instruction had a significant improvement in learners' achievements in Filipino literature and language. Odicta (2017) also believes that the differentiated instruction group has "high" mathematics achievement and "developing" critical thinking skills; while the non-differentiated group has an "average" post-test mathematics achievement and "developed" critical thinking skills. Odicta (2017) in another study on the effects of differentiated instruction on mathematics achievement and critical thinking skills of pupils, a study that employed quasi-experimental. The pre-test mathematics achievement of the two instructional groups – the differentiated and the non-differentiated- are comparably "low", whereas their critical thinking skills are "unreflective". However, post-test results show that the differentiated instruction group has "high" mathematics achievement and "developing" critical thinking skills; while the non-differentiated group has an "average" post-test mathematics achievement and "developed" critical thinking skills. Significant differences were noted in the pre-test and post-test mean gains of the two groups in mathematics achievement and critical thinking skills, in favour of the differentiated group. This is in line with expectations as differentiated instruction is known to surpass traditional instruction in its impact on learning.

However, contrary to some positive outcomes observed in this study, it is essential to consider the potential limitations and alternative perspectives. Despite the reported improvement in pupils' achievement, there may be varying opinions on the long-term sustainability and transferability of differentiated instruction methods across diverse educational settings. Research by Johnson (2018) suggests that the effectiveness of differentiated instruction may be influenced by factors such as teacher training, classroom resources, and student backgrounds. Mulder (2014) in a study also

examined the effect of differentiated instruction on pupils' Mathematics Achievement in primary school classrooms. The results showed that differentiated instruction has no statistically significant effect on pupil Mathematics Achievement, which was against expectations. Cannon (2017) in another study evaluated the relationship between two third-grade mathematics classrooms; one with differentiated pedagogy and the other with traditional pedagogy. The test revealed there was no statistically significant difference in mathematics achievement for third-grade pupils who received differentiated instruction or traditional instruction. Thus, the test revealed that there were no statistically significant differences among mathematics scores (achievement) and the type of instructional pedagogy in which the pupils participated. Although few studies seem to take this position, a plethora of studies appear to state the opposite hence the conclusion of these researchers that DI is effective in improving students' achievement in Mathematics.

This study also revealed that male and female pupils exposed to differentiated instruction did not differ significantly in mathematics achievements in basic schools in FCT, Abuja, Nigeria. This can be explained against the backdrop that because both male and female pupils were taught under the same conditions and during primary school age, there is little or no difference in the achievement of the pupils due to gender. In agreement with this finding is Dania (2014) who investigated the effect of gender on pupils' academic achievement in secondary school social studies. The study revealed that gender (male/female) had no significant effect on pupils' achievement in Social Studies and that, there was a significant interaction effect of treatment and gender on pupils' academic performance in social studies. Goni. The study further confirmed earlier findings by Gidado (2021). Gidado's study on relationships' disparity in Continuous Assessment and examination revealed that gender differences are not a factor in the academic performance of secondary school students when they are exposed to the same classroom environment or teaching methods. Similar conclusions were also reached by Cidado (2021) in his study of Sex differences in Continuous Assessment and examination among History students at the University of Abuja, Nigeria.

Also, Yagana, Ali, and Bularafa (2015) carried out a study to examine the differences between pupils' gender and academic achievement in Colleges of Education in Borno State. The research design for this study is a survey. The study indicated that there were no significant differences between gender and academic performance in Colleges of Education in Borno State. It has become clear that gender differences in academic performance can no longer be empirically supported.

Summary of Findings

The following findings have been made in this study.

- It was also found that those exposed to differentiated instruction had high achievement in mathematics, while those exposed to traditional methods had low achievement.
- This result revealed that the application of differentiated instructions in the teaching of mathematics accounted for the difference in post-test mean achievement of the pupils.
- The study also however found that male and female pupils exposed to differentiated instruction did not differ significantly in mathematics achievement in basic schools in F.C.T, Abuja, Nigeria.

Conclusion

The results from the study indicate that when pupils are exposed to differentiated instruction there is an improvement in achievement in their scores. It was also found that this improvement is irrespective of gender. This implies that gender has no significant influence on pupils' achievement in mathematics when exposed to differentiated instruction. Differentiated instruction is a suitable approach for teaching pupils as it allows learners equal access to the curriculum while maintaining high expectations for them.

Recommendations

It is therefore recommended that:

1. Differentiated instruction should be implemented to promote achievement for pupils learning mathematics and
2. Differentiated instruction should be used as a learning approach for pupils of both genders and the outcome is not gender biased.

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