International Journal of
Science, Architecture, Technology and Environment

The Effects of Differentiated Instruction on the Academic Achievement of Basic Science Pupils in Mixed-Ability Classrooms in Gwagwalada, Abuja.

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DOI: https://doi.org/10.63680/ijsate062625.61

Abstract

The study examined the effects of differentiated instruction on the academic achievement of Basic Science learners among low achievers and high achievers in a mixed-ability classroom. It explored the strategies used by teachers to apply core principles of differentiated instruction in mixed-ability settings and monitored how pupils progressed academically. A total of 60 pupils (33 males, 27 females) from two intact classes served as the sample for this experimental study, which was conducted on 35 low achievers and 25 high achievers.
The instrument used for data collection was the Basic Science Achievement Test (BSAT), which was validated by lecturers in the Department of Science Education, University of Abuja. The BSAT's reliability was established using the Kuder-Richardson Formula 20 (KR-20), yielding a reliability coefficient of 0.89. Research questions were answered using mean and standard deviation, while the hypotheses were tested using Analysis of Covariance (ANCOVA) at a 0.05 level of significance.
The findings revealed a significant improvement in the academic scores of low achievers following the implementation of differentiated instruction. However, for high achievers, no significant difference was observed. It is evident that differentiated instruction is a teaching strategy that exerts a strong positive effect on the academic achievement of low-achieving pupils in Basic Science.

Keywords: Mixed Ability, Basic Science, Achievement, Basic Science

1. Introduction

Introduction and Background

Today's classrooms are full of pupils with different learning needs, abilities, interests, and learning styles. They all learn at their own pace. This diversity makes teaching more challenging, as teachers must find ways to support both individual pupils and the whole class. As classrooms become more varied, we need bigger changes in how we teach and structure lessons. Because of this, the teacher's job is changing — moving away from just giving information to helping pupils learn, often working in teams with different roles (Bender, 2012). Apart from teaching, educators also have to consider many personal factors like pupils' emotions, health, thinking ability, study habits, interests, and learning speed

The teacher must address these student-centered factors effectively to accomplish the objectives of instruction and improve academic outcomes. Academic achievement represents performance outcomes that indicate the extent to which a learner has accomplished specific goals that were the focus of activities in instructional environments (Ricarda et al., 2015). According to Hattie (2009), academic achievement is typically expressed as a numerical score obtained through standardized assessments indicative of an individual's intellectual capacity. In modern societies, academic achievement plays a pivotal role in a person's life. Richardson et al. (2012) noted that academic achievement, measured by grade point averages or standardized assessments designed for selection purposes, determines whether a student will have the opportunity to advance their education. Therefore, optimizing academic achievement remains a central area of interest for science educators.

Basic Science is the study of the basic principles of the natural world — including living and non-living things, energy, matter, the environment, and how they interact Basic Science plays a significant role in the technological growth of any nation, as its foundational concepts are par of the disciplines like Biology, Physics, and Chemistry. Basic Science literacy deeply influences the healthcare sector, industrial technology, military infrastructure, and environmental management. Despite its crucial importance to scientific and technological development, the academic achievement of pupils in Basic Science has historically remained average.

This trend of poor performance in science education can be largely attributed to rigid instructional methods among the many factors in science literature. The combination of methods can improve science achievement as teachers and researchers continuously searching for pedagogical innovations. However, many conventional methods fail to account for the individual differences that pupils bring into the Basic Science classroom, rendering efforts toward improving academic achievement less effective.

While any group of pupils is likely to demonstrate considerable variation in learning profiles, the characteristics displayed by those who perceive science as difficult—or who experience learning disorders—necessitate a rich variety of learning activities within the general education classroom. Pupils facing learning challenges may exhibit lower task engagement, difficulties processing multiple instructions, and disorganized thinking or work habits. When these deficits couple with severe academic gaps, the classroom environment becomes highly challenging for Basic Science teachers, leaving them in need of tactical, evidence-based ideas that work (Bender, 2008). The differentiated instructional framework, while appropriate for virtually all-inclusive general education classes, is particularly helpful to pupils managing this array of learning challenges.

The idea of differentiated instruction came about because teachers saw the need to actively change their teaching methods to support students with different learning needs in normal classrooms (Carolan & Guinn, 2007). Okigbo and Chukwuma (2014) described it as a teacher's purposeful way of responding to the varied needs of their students. Teachers need to truly understand their learners — not only their academic ability and level, but also their preferred learning styles and what interests them. When building this approach, Carol Ann Tomlinson drew from a wide range of studies on how students learn. She connected it closely to Howard Gardner's theory of multiple intelligences and research on brain-friendly teaching (Gardner, 2006).

On diverse learning styles, teachers are encouraged to personalize learning activities so that lessons become more interactive, meaningful, and engaging for students (Carolan & Guinn, 2007). They should pay attention to each pupil's unique learning profile and adjust activities to match. In essence, differentiated instruction is a teaching method where educators deliberately change their teaching approaches, resources, activities, and assignments to meet the needs of individual students and small groups. This helps give every child better learning opportunities and improves academic achievement in the classroom (Miles, 2015).

Statement of the Problem

Currently, many things affect pupils' academic achievement. Although researchers have studied some of these factors deeply, very little attention has been given to the unique learning needs that pupils show every day in the science classroom. In most cases, teaching is not tailored to meet students' specific needs. Instead, science teachers tend to focus more on completing the curriculum, covering all topics for the term, and conducting standard tests and examinations (Tomlinson, 2014).

Furthermore, science learning can sometimes be influenced by gender-stereotyped experiences. In many science classes, female pupils may express anxiety when interacting with unfamiliar laboratory materials or abstract experimental concepts. When such anxiety takes hold, they exhibit specialized learning needs. If these needs are left unaddressed by teachers, female pupils may become disengaged and achieve poorly, which frequently leads them to opt out of science-related disciplines later in life. Conversely, while male pupils might not always exhibit the same visible anxieties, they manifest distinct academic needs related to baseline knowledge deficits or cognitive confusion. These challenges demand that Basic Science teachers attend closely to individual differences through differentiated instructional modes. Against this background, this study investigates the effects of differentiated instruction modes on the academic achievement of low-achieving and high-achieving Basic Science pupils.

Purpose of the Study

The purpose of this study was to investigate the effects of differentiated instruction modes on the academic achievement of Basic Science pupils in mixed-ability classrooms within in Gwagwalada Area Council of Abuja].

Specifically, the study sought to determine the:

1. Difference between the mean achievement scores of low achievers and high achievers taught Basic Science using differentiated instructional modes.
2. Difference between the mean achievement scores of male and female pupils taught Basic Science using differentiated instructional modes.

Research Questions

The following research questions guided the study:

1. What is the difference between the mean achievement scores of low-achieving and high-achieving pupils taught Basic Science using differentiated instructional modes?
2. What is the difference between the mean achievement scores of male and female pupils taught Basic Science using differentiated instructional modes?

Hypotheses

The following null hypotheses were tested at a 0.05 level of significance:

1. There is no significant difference between the mean achievement scores of low-achieving and high-

achieving pupils taught Basic Science using differentiated instructional modes.

2. There is no significant difference between the mean achievement scores of male and female pupils taught Basic Science using differentiated instructional modes.

Methodology

Research Design

The study adopted a pretest-posttest non-equivalent control group quasi-experimental research design, utilizing a 2 x 2 factorial matrix. This design was appropriate because intact classes were used to avoid disrupting the administrative structure of the school, preventing the random assignment of individual participants. The independent variable was the instructional approach (differentiated instruction), while the moderating variables were the pupils' baseline achievement levels (low achieving vs. High achieving) and gender (male vs. Female).

Population and Sample

The target population for this study comprised all Primary Four (4) pupils within public primary schools in the Gwagwalada Area Council of the Federal Capital Territory, Abuja. A simple random sampling technique was utilized to select one public primary school to serve as the study site. From this school, two intact Primary Four classes were randomly assigned to experimental and control conditions. The total sample size consisted of 60 pupils (33 males and 27 females). Based on baseline pretest screening, the sample was further categorized into 35 low-achieving pupils and 25 high-achieving pupils.

Instrumentation

The research instrument used for data collection was a researcher-designed achievement test titled the Basic Science Achievement Test (BSAT). The test items were carefully drawn from the standardized national Primary Four Basic Science scheme of work. The BSAT consisted entirely of objective multiple-choice questions designed to assess pupils' knowledge, comprehension, and application of foundational science concepts.

To ensure face and content validity, a draft copy of the BSAT was submitted to expert reviewers in the Department of Educational Foundations, University of Abuja, alongside two experienced primary school Basic Science teachers. Their corrections and recommendations regarding item clarity and curriculum alignment were integrated into the final instrument. To establish internal consistency, the instrument was pilot-tested on a non-participating cohort of Primary Four pupils. The resulting data were analyzed using the Kuder-Richardson Formula 20 (KR-20}), which yielded a high reliability coefficient of 0.89, confirming the instrument's suitability for empirical data collection.

Method of data Analysis

The data collected from both pretests and posttests were analyzed using descriptive and inferential statistics. Mean and standard deviation scores were computed to answer the research questions. The null hypotheses were tested at a 0.05 level of significance using Analysis of Covariance (ANCOVA), with pretest scores serving as the covariates to control for any initial differences in baseline ability.

Presentation of Results

This section presents the result and interpretation of data collected from the study based on research questions and hypotheses.

Answers to research questions

1. What is the difference between the mean achievement scores of low-achieving and high-achieving pupils taught Basic Science using differentiated instructional modes?

Table 1: Mean and Standard Deviation of Achievement Scores of Low and High Achievers

Group	N	Pre-test Mean	SD.	Post-test Mean	Mean Gain
Low Achiever	35.	43.55.	4.66.	70.35.	22.82
High Achiever	25.	70.35	3.56.	72.56.	2.26

Table 1 shows the Low and High Achiever Pupils taught Basic Science using DIM in the instructional delivery. The Low Achiever had pre-test Mean achievement score of 43.55 and post-test mean score of 70.35 with gain in mean score of 22.82, while those in the High Achiever's group had pre-test mean score of 70.35 and post-test mean score of 72.56 with Gain in mean 2.26. The low achievers' group had higher spread of scores in the post-test than those in the High Achiever's group. The Use of DIM was more pronounced with the High Achiever's group with mean gain of 22.82.

2. What is the difference between the mean achievement scores of male and female pupils taught Basic Science using differentiated instructional modes?

Table 2: Shows Mean and Standard Deviation of Achievement Scores of Male and Female Pupils taught with Differentiated Instruction.

Group	N	Pre-test Mean	SD.	Post-test Mean	Mean Gain
Male	33.	72.55.	6.66.	81.37.	8.82
Female	27.	55.40	5.56.	60.56.	5.16
Total	60				

Table 2 shows the Mean Achievement scores of Male and Female Pupils taught Basic Science using DIM in the instructional delivery. The Male pupil had a pre-test Mean achievement score of 72.55 and post-test mean score of 81.37 with gain in mean score of 8.82, while those in the Female group had pre-test mean score of 55.40 and post-test mean score of 60.56 with Gain in mean 5.16. The Male pupils had a higher mean of scores in the post-test than those in the Female Pupils. The Male pupils of DIM had a higher mean gain of 8.82.

Testing the Hypotheses

1. There is no significant difference between the mean achievement scores of low-achieving and high-achieving pupils taught Basic Science using differentiated instructional modes.

Table 3: ANCOVA of pupils Achievement Scores by Ability

Source	Type III Sum Of Squares	Df	Mean Square	F	Sig
Corrected Model	3192.625a	4	798.156	20,945	.000
Intercept	2489.769	1	2289.769	65.337	.000
Pretest	2908.833	1	2208.833	76.334	.000
Ability Group	224084	1	224.084	6.012	.001
Error	2172.085	55	38.107		
Total	280476.00	59			
Corrected Total	5364.710	60			

Significant at P<Than 0.05; and df-61 (Adjusted R Squared = .567)

Table 3 Shows that at 0.05 level of significance, 1df numerator and 59 df denominator, the calculated F is 6.012 with P value of .001 which is less than 0.05. The null hypothesis was rejected. Therefore, there is Significant difference in the mean achievement scores of higher achiever pupils taught Basic science using differentiated Instructional modes than those Basic Science using the same method. This was in favour of Lower Achievers
.

Hypothesis 2: There is no significant difference between the mean achievement scores of male and female using Differentiated Instructional Mode.

Table 4; ANCOVA of Experimental Group Achievement Scores by Gender

Source	Type III Sum Of Squares	Df	Mean Square	F	Sig
Corrected Model	2239.003a	2	619.502	15.934	.000
Intercept	2368.933	1	4268.933	65.635	.000
Pre-test	797.654	1	797.654	23.292	.000
Gender	332.004	1	332.004	11.396	.067
Error	1609.232	56	51.911		
Total	83604.000	59			
Corrected Total	2848.235	60			

Significant at P>Than 0.05; and df-59 (Adjusted R Squared = .567)

Table 4 shows that at 0.05 level of significance, 1df numerator and 56 df denominator, the calculated F is 11.4 With P-value of .067 which is greater than 0.05. The null hypothesis was accepted. Therefore, there is no significant Difference between the mean achievement scores of male and female students taught Basic using Differentiated instructional modes.

Discussion of Findings

The findings of this study show that the Differentiated Instruction Mode (DIM) significantly improved the posttest academic achievement scores of low-achieving primary school pupils in Basic Science. This is evident by the mean gain score of 22.82 recorded by the by the group. This outcome demonstrates that when core science concepts are broken down and modified to suit distinct learning readiness levels and individual learning speeds, children who are low achiever and struggle in a rigid classroom setting can achieve well.

This profound achievement by h low achievers strongly supports the findings of modern classroom setup. For instance, Suprayogi et al. (2017) observed that tailoring pedagogical pathways to meet specific learner deficits raises the achievement of underperforming students. The result also aligns c with the practical assertions of Bondie et al. (2019), who maintained that differentiated instructional strategies assist pupils facing learning challenges within inclusive environments. Similarly,

In contrast, the findings revealed that for high-achieving pupils, the use of differentiated instruction did not yield a statistically significant difference in academic scores, aevidenced by a marginal mean gain of 2.21. This indicates that while the high achievers maintained a stable and excellent standard of achievement, their academic growth rate under DIM did not mirror the the improvement as seen in their low-achieving peers. This finding is in li with the work of Smets and Struyven (2020), who argued that while differentiation ensures high achievers remain engaged with enriched content, their score increments on standardized assessments are often minor because they are already operating at an excellent level.

However, this lack of obvious progress among high achievers stands in contrast to some contemporary studies iin science education. For instance, Little et al. (2014) posited that high-quality differentiation must simultaneously push high-ability students toward advanced tiers of intellectual climax, resulting in distinct and measurable performance jumps. Furthermore, Steenbergen-Hu et al. (2016) discovered that when curriculum compacting and advanced enrichment tasks are rigidly sustained within a differentiated model, high achievers demonstrate significant, noticeable increases in science literacy and standardized test scores compared to those in non-differentiated classrooms. The difference in this study suggests that the Primary Four Basic Science Achievement Test (BSAT) is highly effective at capturing academic growth while exhibiting a stable effect for pupils who had already mastered fundamental competencies.

Regarding the second variable, the inferential analysis established that there was no statistically significant difference between the mean achievement scores of male and female pupils taught Basic Science using the Differentiated Instruction Mode. Although male pupils recorded a higher descriptive posttest mean score and mean gain, the ANCOVA results confirmed that gender did not exert a significant main effect on performance. This finding aligns with the research of Juuti et al. (2021), who argued that modern, activity-based science instructional strategies benefit male and female students equally when individual learning styles and voices are respected. This lack of of drastic difference between the male and female demonstrates that DIM operates as an equitable, gender-neutral capable of supporting all children in science education without systemic bias.

Conclusion

The study concludes that adopting the use of differentiated instructional mode as a method of teaching Basic Science improves Lower Achievers pupils more Higher Achiever pupils. The use of differentiated Instruction also helps pupils with lower achievement to meet their academic needs.

Recommendation

The following recommendations are made in the light of the findings of the study:

1. Seminars and workshops should be organized by educational administrators for Basic Science teachers on how to use differentiated instructional modes in the Basic Science classroom.

2. Effort should be made by science teachers to learn and master how to plan instructional plans using Differentiated instructional modes.
3. In differentiating instructions for pupils, the teachers should endeavor to carry all pupils along and meet Their needs irrespective of gender.
4. Curriculum planners and teacher-training institutions should integrate differentiated instructional strategies into pre-service and in-service teacher education programmes.

Declaration of Conflicting Interests

The authors declare no potential conflicts of interest with respect to the research, authorship and publication of this article.

Funding

The author received no financial support for the research, authorship and publication of this article.

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