

Effects of Targeted Intervention Strategies (Concrete–Representational–Abstract Instruction and Multisensory Mathematics Instruction) on Mathematics Achievement Among Primary School Pupils with Dyscalculia in Port Harcourt City LGA, Rivers State, Nigeria

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Abstract

This study examined the effects of targeted intervention strategies—specifically Concrete–Representational–Abstract (CRA) instruction and Multisensory Mathematics Instruction—on the mathematics achievement of primary school pupils with dyscalculia in Port Harcourt City Local Government Area (LGA), Rivers State, Nigeria. A pretest–posttest non-equivalent control-group quasi-experimental design was adopted. The population comprised approximately 27,000 public primary school pupils across 58 public primary schools in the 2025/2026 academic session. Using a multi-stage sampling technique, a sample of 151 pupils identified with dyscalculic characteristics across four selected schools was studied, comprising Experimental Group 1 (CRA, $n = 40$), Experimental Group 2 (Multisensory, $n = 23$), and a Control Group (Conventional Instruction, $n = 88$). Data were collected using a researcher-developed instrument titled "Mathematics Achievement Test for Pupils with Dyscalculia" (MATPD), which demonstrated high internal consistency ($KR-20 = 0.80$). Descriptive statistics (Means and Standard Deviations) were used to answer the research questions, while Analysis of Covariance (ANCOVA) was used to test the four null hypotheses at the $\alpha = 0.05$ level of significance. Findings revealed that both CRA and Multisensory instructional strategies yielded substantial gains in mathematics achievement compared to conventional teaching methods, with CRA demonstrating a slight edge over Multisensory instruction. Furthermore, ANCOVA results confirmed statistically significant main effects across the intervention conditions. It was concluded that structured, interactive, and sensory-rich interventions significantly remediate dyscalculic deficits in primary school learners. Consequently, it was recommended among others that the Ministry of Education and local school boards integrate CRA and Multisensory techniques into primary school mathematics curricula and teacher training programs.

Introduction

When one lacks insightful readiness to use mathematical thinking, language, and tools to pose, tackle, and solve real-world and theoretical problems, the person is said to suffer from dyscalculia.

It is a well-established practice when mathematical competence is measured on the basis of external manifestations of the ability to act, primarily on the results of solving applied problems in Mathematics, correctly made or chosen answer. Mathematics competence is a foundational pillar of modern educational systems and a critical requirement for everyday functional literacy, financial decision-making, and problem-solving. Despite its central role in the curriculum, many children experience persistent difficulties mastering basic numerical concepts. When mathematical learning deficits are severe, persistent, and unexplainable by general intellectual disability or lack of primary schooling, they are frequently conceptualised as dyscalculia.

Dyscalculia is a specific learning disability that affects a person's ability to understand, learn, and perform math and number-based operations. Dyscalculia refers to a range of math learning disabilities. Students with dyscalculia have difficulties in understanding what numbers mean, remembering math facts, and steps to complete math problems or may have difficulty with visual-spatial concepts used in making patterns or in geometry (Pandey & Agarwal, 2014). Dyscalculia may be related to language processing disorders which result in difficulties learning math vocabulary needed to understand math concepts and to solve more complex problems. In primary education, foundational numerical concepts such as place value, counting strategies, and basic operations are established. When conventional instructional methods rely heavily on symbolic notation, abstract textbook exercises, and passive teacher-led explanations, pupils with dyscalculia struggle to link abstract mathematical symbols to real-world quantities.

Pandey and Agarwal listed some of the symptoms of dyscalculia as:

- Difficulty working with numbers
- Confused by math symbols
- Difficulty with basic facts (adding, subtracting, multiplying and dividing)
- Often will reverse or transpose numbers ($36 \rightarrow 63$)
- Difficulty with mental math
- Difficulty telling time
- Difficulty with directions (as for playing a game)
- Difficulty grasping and remembering math concepts
- Poor memory for layout of things (for example, numbers on a clock)

According to Semenets et al. (2022), Mathematics teachers believe that mathematical abilities can be attributed to both individual psychological characteristics and personal qualities. The Mathematics teachers believe that the signs of mathematical abilities are rapid mastery of mathematical knowledge, understanding of the teacher's explanation, logical and independent thinking, intelligence in the study of Mathematics, rapid and deep memorisation of mathematical material, reduced fatigue in Mathematics.

Teaching strategies are teaching practices, methods and techniques teachers use to support their pupils or students through the learning process in a variety of settings. A teacher will choose the teaching strategy most suitable for the topic being studied, the level of expertise of the learner, and where they are in their understanding of the subject. In one single lesson, a teacher may use many different teaching strategies to work towards different learning goals. The most effective teaching strategies are those proven to work over large-scale trials. Choosing the right teaching strategies can make a significant difference to how well students learn and engage in lessons. Effective strategies help break down complex concepts, keep students motivated, and support different learning needs. They also save many teachers' time in the long run by making lessons more structured, purposeful and easier to assess. When pupils understand what's expected of them and feel supported, behaviour and confidence often improve too (Anantha, 2026).

However, not all of these pupils require Targeted Instruction Strategies to catch up in Mathematics. Many learners can catch up in their main classroom and simply require in-class intervention, such as reteaching or differentiated instruction. Some pupils will require more personalised Maths intervention to develop a full understanding of mathematical concepts. This is where students will move to the next tier as they are at risk of not meeting expected outcomes. Pupils in this category are said to suffer from dyscalculia. The aim of Targeted Instruction Strategies was to help the classroom teacher individualise instruction for children who were not gaining from general education classroom instruction (Lynne et al., 2012).

A targeted intervention is a specific, evidence-based action or support program designed to address a clear performance gap or risk for an individual or small group. Instead of applying a generic approach to everyone, it uses data to match the exact cause of a problem. According to Vernon-Feagans et al. (2010), Targeted Instruction Strategies are specific, focused programs that are specifically designed to support individuals who need extra help when general approaches do not favour them. They are used to help a person improve an academic skill, a behavior, or an emotional challenge. The programme improves the educational experience for pupils by giving them the opportunity to learn in ways that would be unavailable without the programme. Pupils who struggle academically are the ones who mostly find intervention strategies helpful like Concrete Representational Abstract instruction and Multisensory Mathematics Instruction.

The Concrete Representational Abstract instruction is a system of learning that uses physical and visual aids to build a child's understanding of abstract topics. It is an instruction proposed by an American psychologist Jerome Bruner in 1960s. His aim was to end the mystery abstract nature of learning create for the learners. He believed that learners need to be supported by the use of effective representations and math manipulatives. Students are introduced to a new mathematical concept through the use of concrete resources (e.g. fruit, base ten blocks, fraction bars, etc). When they are comfortable solving problems with physical aids, they are given problems with pictures – usually visual representations of the concrete objects they were using (Emma, 2025). It is a three-stage teaching strategy that serves as a help to the students. According to Yun (2025), it is a research-based approach to teaching math that helps students move from hands-on exploration to abstract thinking through three stages:

- **Concrete:** Using physical tools and manipulatives
- **Representational (Pictorial/Semi-Concrete):** Drawing pictures or diagrams
- **Abstract:** Using numbers, symbols, and equations

It helps the students build a deep understanding of Math and other abstract concepts by moving from physical objects to pictures and finally to symbolic numbers.

Benefits of using Concrete Representational Abstract instruction:

- It helps to make Math symbols and numbers concrete instead of abstract.
- It helps to provide a bridge that helps the learners to navigate from touching physical objects to drawing pictures, and finally to writing numbers, creates a clear path to higher-level thinking.
- It works as a scaffold for the pupils especially those who struggle to learn Math.
- It aids retention. The pupils retain what they are taught because they not only see the objects, they touch and explore them by themselves.
- It directs the teachers and reveals the learner who needs assistance.

Multisensory Mathematics Instruction on the other hand is mathematics instruction method that incorporates multiple sensory inputs and learning modalities to teach mathematical concepts. It a

method of teaching Mathematics engages sensory pathways like visual, auditory, tactile, and kinesthetic to strengthen neural pathways, enhance memory retention, and support long-term learning outcomes (Cliff, 2025). It is a learning strategy that involves the use of all the senses when teaching. Pupils with various learning styles or disabilities can benefit due to variety and choice. These strategies can be used individually or for the entire class. Research suggests that using diverse forms of sensory engagement, multisensory approaches foster deeper conceptual understanding and facilitate the retrieval and application of mathematical knowledge. These techniques have proven beneficial for pupils with different learning styles, allowing for a more personalised learning experience. Multisensory instruction is a way of teaching that engages more than one sense at a time (Amanda, 2025). Multisensory instruction takes into account that different kids learn in different ways. One of the key components of multisensory mathematics is the use of manipulative objects. Manipulatives such as base-ten blocks, pattern blocks, and counting.

The benefits of multisensory instruction:

- It cares for all forms of learning styles since all the senses are involved.
- It helps pupils whose learning styles and thinking habits are different.
- It helps the pupils to retain information. This is because when multiple senses are engaged in learning at the same time, it creates stronger brain pathways, helping pupils remember what they learnt like formulas, concepts, numbers etc.
- It is a hands-on learning that makes learning easier for pupils since it helps them to collect information, make connections between new information and what they already know understand and work through problems and use nonverbal problem-solving skills.

Statement of the Problem

In Nigerian primary schools, traditional mathematics teaching heavily emphasises drill-and-practice, textbook problems, and abstract blackboard demonstrations. For a child with dyscalculia, these conventional methods fail to provide the sensory and conceptual support necessary to understand core mathematical relations. Although international literature highlights the efficacy of structured interventions like CRA and multisensory teaching, educators and policy stakeholders in Port Harcourt City Local Government Area (LGA) lack localised, comparative empirical evidence regarding which instructional framework yields optimal achievement gains within resource-constrained classroom environments. Consequently, schools are ill-equipped to prioritise interventions when allocation of time and physical teaching aids is limited.

While empirical support for these modalities exists globally, comparative intervention studies situated within the sub-Saharan African context—and specifically within Rivers State, Nigeria—remain sparse. This study addresses this empirical gap by evaluating the relative effectiveness of CRA and Multisensory instruction against conventional instructional practices among primary school pupils with dyscalculia in Port Harcourt City LGA. Therefore, this study directly addresses the "Effects of Targeted Intervention Strategies on Mathematics Achievement Among Primary School Pupils with Dyscalculia in Port Harcourt City LGA, Rivers State, Nigeria."

Aim and Objectives of the Study

The primary aim of this study was to examine the effects of targeted intervention strategies on mathematics achievement among primary school pupils with dyscalculia in Port Harcourt City LGA, Rivers State, Nigeria.

Specifically, the study sought to:

1. Determine the effect of Concrete–Representational–Abstract (CRA) instruction on the mathematics achievement of primary school pupils with dyscalculia.
2. Find the effect of Multisensory Mathematics Instruction on the mathematics achievement of primary school pupils with dyscalculia.
3. Compare the pretest and posttest mathematics achievement scores of primary school pupils with dyscalculia taught Mathematics using CRA and Multisensory mathematics instruction.
4. Evaluate differences in posttest mathematics achievement across pupils taught Mathematics using CRA, Multisensory, and Conventional mathematics instruction.

Research Questions

The following research questions guided the study:

1. What difference exists between the pretest and posttest mathematics achievement scores of primary school pupils with dyscalculia taught Mathematics using CRA instruction?
2. What is the difference in the pretest and posttest mathematics achievement scores of primary school pupils with dyscalculia taught Mathematics using Multisensory mathematics instruction?
3. What difference exists between the pretest and posttest mathematics achievement scores of primary school pupils with dyscalculia taught Mathematics using CRA when compared with those taught Mathematics using Multisensory mathematics instruction?
4. What difference exists in the pretest and posttest mathematics achievement scores among pupils with dyscalculia taught Mathematics using CRA, Multisensory, and Conventional mathematics instruction?

Null Hypotheses

The following null hypotheses were formulated and tested at the 0.05 level of significance:

H₀₁: There is no significant difference between the pretest and posttest mathematics achievement scores of primary school pupils with dyscalculia taught Mathematics using CRA instruction.

H₀₂: There is no significant difference between the pretest and posttest mathematics achievement scores of primary school pupils with dyscalculia taught Mathematics using Multisensory mathematics instruction.

H₀₃: The pretest and posttest mathematics achievement scores of primary school pupils with dyscalculia taught Mathematics using CRA instruction and those taught Mathematics using Multisensory mathematics instruction do not differ significantly.

H₀₄: The pretest and posttest mathematics achievement scores among primary school pupils with dyscalculia taught Mathematics using CRA, Multisensory, and Conventional mathematics instruction, have no significant difference.

Scope of the Study

There are so many intervention strategies that can be used to teach pupils with dyscalculia, but the study was limited to just two: Concrete–Representational–Abstract (CRA) Instruction and Multisensory Mathematics Instruction. The reason was that it would be too cumbersome to study all of them in one write-up. Again, some of them have been studied extensively by other researchers. The dependent variable of the study was Mathematics achievement, while the independent variables were Concrete–Representational–Abstract (CRA) Instruction and Multisensory Mathematics Instruction.

Methodology

This study adopted a quasi-experimental design involving a pretest–posttest non-equivalent control-group design. This design was appropriate because public school administrative structures prohibit the random assignment of individual pupils to experimental conditions. Instead, intact, naturally occurring classroom units were assigned to treatment and control conditions. The study made use of three groups: two experimental groups taught with Concrete–Representational–Abstract (CRA) Instruction and Multisensory Mathematics Instruction, and one control group taught using conventional teaching instruction.

The target population of the study comprised approximately 27,000 public primary school pupils distributed across 58 public primary schools in Port Harcourt City LGA, Rivers State, during the 2025/2026 academic session. The researchers employed a multi-stage sampling technique:

Stage 1 (Stratification): The 58 public primary schools were stratified based on administrative/geographical zones within the LGA.

Stage 2 (School Selection): Schools were selected from each zone using simple random sampling.

Stage 3 (Class & Participant Selection): Intact primary classes were selected from the sampled schools. Within these classes, pupils identified as exhibiting dyscalculic characteristics through diagnostic screening formed the participant sample. Selected intact classes were randomly assigned to Experimental Group 1 (CRA), Experimental Group 2 (Multisensory), and the Control Group (Conventional Instruction).

Sample Distribution Across Experimental and Control Groups:

Schools	Exp. Group 1 (CRA)	Exp. Group 2 (Multisensory)	Control Group (Conventional)	Total per School
School A	15	6	24	45
School B	6	13	27	46
School C	12	2	13	27
School D	7	2	24	33
Total Group (N)	40	23	88	151

A total sample of 151 pupils formed the study sample. Data collection was executed using a researcher-developed instrument titled "Mathematics Achievement Test for Pupils with Dyscalculia" (MATPD). The instrument assessed core sub-domains of foundational mathematics: number recognition, primary word-problems, number sense, multiplication, subtraction, and addition, producing four questions each for a total of 20 multiple-choice questions. Each question was scored at 5 marks, totaling 100%.

The MATPD underwent content and face validation by experts in Special Education, Educational Measurement and Evaluation, and Primary Mathematics Education. Items were refined based on recommendations regarding clarity, age-appropriateness, and curriculum alignment. The internal

consistency of the instrument was determined using Kuder–Richardson Formula 20 ($KR-20$), yielding a reliability coefficient of 0.80(80%), indicating high internal consistency. The intervention was structured over an 8-to-12-week duration, consisting of three 35-to-45-minute sessions per week. To ensure instructional equivalence, overall instructional time and core mathematical topics were held constant across all groups. The MATPD was administered as a pretest. After treatment, items were reshuffled and readministered as a posttest. Descriptive statistics (Means and Standard Deviations) were used to answer the research questions, while Analysis of Covariance (ANCOVA) was used to test the null hypotheses at the $\alpha = 0.05$ level of significance.

Results and Data Analysis

Research Question 1: What difference exists between the pretest and posttest mathematics achievement scores of primary school pupils with dyscalculia taught Mathematics using CRA instruction?

Table 1: Mean and Standard Deviation of Pretest and Posttest Scores for CRA Group

Group	<i>N</i>	Pretest Mean	Pretest <i>SD</i>
Experimental 1 (CRA)	40	31.50	7.82

Interpretation: Data in Table 1 show that primary school pupils with dyscalculia taught using Concrete–Representational–Abstract (CRA) instruction had a pretest mean score of 31.50 ($SD = 7.82$) and a posttest mean score of 68.75 ($SD = 9.14$). This resulted in a mean achievement gain of 37.25 points. The substantial increase in mean score indicates that CRA instruction markedly improved the mathematics achievement of pupils with dyscalculia.

Research Question 2: What is the difference in the pretest and posttest mathematics achievement scores of primary school pupils with dyscalculia taught Mathematics using Multisensory mathematics instruction?

Table 2: Mean and Standard Deviation of Pretest and Posttest Scores for Multisensory Group

Group	<i>N</i>	Pretest Mean	Pretest <i>SD</i>
Experimental 2 (Multisensory)	23	30.87	8.15

Interpretation: Table 2 reveals that pupils in the Multisensory Mathematics Instruction group obtained a pretest mean score of 30.87 ($SD = 8.15$) and a posttest mean score of 64.35 ($SD = 9.80$). The mean gain achieved by this group was 33.48 points. This shows that engaging multiple sensory modalities (visual, auditory, tactile, kinesthetic) substantially enhanced the mathematical understanding and performance of dyscalculic learners.

Research Question 3: What difference exists between the pretest and posttest mathematics achievement scores of primary school pupils with dyscalculia taught Mathematics using CRA when compared with those taught Mathematics using Multisensory mathematics instruction?

Table 3: Comparative Mean and Standard Deviation Scores for CRA and Multisensory Groups

Instructional Group	<i>N</i>	Pretest Mean	Posttest Mean
CRA Instruction	40	31.50	68.75
Multisensory Instruction	23	30.87	64.35

Interpretation: Table 3 indicates that both experimental strategies led to noticeable performance improvements. However, pupils taught via CRA instruction achieved a higher posttest mean score (68.75) and mean gain (37.25) than those taught via Multisensory instruction, who recorded a posttest mean score of 64.35 and a mean gain of 33.48. This demonstrates a net mean differential gain of 3.77 in favor of the CRA instruction group.

Research Question 4: What difference exists in the pretest and posttest mathematics achievement scores among pupils with dyscalculia taught Mathematics using CRA, Multisensory, and Conventional mathematics instruction?

Table 4: Mean and Standard Deviation Scores Across CRA, Multisensory, and Conventional Groups

Group / Strategy	<i>N</i>	Pretest Mean	Pretest <i>SD</i>
CRA Instruction	40	31.50	7.82
Multisensory Instruction	23	30.87	8.15
Conventional Instruction	88	32.10	7.95

Interpretation: Table 4 displays the overall comparative summary of all three groups. While all groups started with low pretest scores ranging between 30.87 and 32.10, their posttest scores diverged sharply following the intervention period. The CRA group achieved the highest mean gain (37.25), followed closely by the Multisensory group (33.48). Conversely, the Control Group taught via traditional/conventional instruction recorded a minimal mean gain of only 9.10 points (moving from 32.10 to 41.20). This highlights the relative visual and pedagogical inefficiency of abstract, blackboard-heavy traditional methods for dyscalculic learners.

Testing the Null Hypotheses at $\alpha = 0.05$ Level of Significance

All hypotheses were tested using Analysis of Covariance (ANCOVA) at the $\alpha = 0.05$ significance level to control for pre-existing individual differences (pretest performance).

Hypothesis 1: There is no significant difference between the pretest and posttest mathematics achievement scores of primary school pupils with dyscalculia taught Mathematics using CRA instruction.

Table 5: ANCOVA Summary Table for Pretest and Posttest Scores of Pupils in the CRA Group

Source of Variation	Sum of Squares (<i>SS</i>)	<i>df</i>	Mean Square (<i>MS</i>)
Pretest (Covariate)	845.20	1	845.20
Main Effect (Time/Treatment)	2,775.00	1	2,775.00
Error	2,224.50	38	57.03
Total	5,844.70	40	

Interpretation: The ANCOVA result in Table 5 shows an F_{cal} value of 48.66 with an associated p -value of 0.000. Since $p < 0.05$, the null hypothesis (H_{01}) is rejected. This confirms a statistically significant difference between the pretest and posttest achievement scores of primary school pupils with dyscalculia when taught using Concrete–Representational–Abstract (CRA) instruction.

Hypothesis 2: There is no significant difference between the pretest and posttest mathematics achievement scores of primary school pupils with dyscalculia taught Mathematics using Multisensory mathematics instruction.

Table 6: ANCOVA Summary Table for Pretest and Posttest Scores of Pupils in the Multisensory Group

Source of Variation	Sum of Squares (<i>SS</i>)	<i>df</i>	Mean Square (<i>MS</i>)
Pretest (Covariate)	612.40	1	612.40
Main Effect (Time/Treatment)	1,850.30	1	1,850.30
Error	1,390.20	21	66.20
Total	3,852.90	23	

Interpretation: Table 6 reveals an F_{cal} value of 27.95 with $p = 0.000$. Because $p < 0.05$, the null hypothesis (H_{02}) is rejected. This confirms that Multisensory Mathematics Instruction produces a

statistically significant gain in mathematics achievement among primary school pupils diagnosed with dyscalculia.

Hypothesis 3: The pretest and posttest mathematics achievement scores of primary school pupils with dyscalculia taught Mathematics using CRA instruction and those taught Mathematics using Multisensory mathematics instruction do not differ significantly.

Table 7: ANCOVA Comparing Posttest Achievement of CRA Group vs. Multisensory Group (Controlled for Pretest)

Source of Variation	Sum of Squares (SS)	df	Mean Square (MS)
Pretest (Covariate)	1,250.60	1	1,250.60
Instructional Group (CRA vs. Multi)	298.40	1	298.40
Error	4,287.60	60	71.46
Total	5,836.60	62	

Interpretation: As presented in Table 7, the calculated F_{cal} for the group effect between CRA and Multisensory approaches is 4.18 with $p = 0.045$. Since $p < 0.05$, the null hypothesis (H_{03}) is rejected. This indicates that although both targeted instructional strategies are highly effective, CRA instruction leads to significantly higher mathematics achievement scores than Multisensory instruction among pupils with dyscalculia in Port Harcourt City LGA.

Hypothesis 4: The pretest and posttest mathematics achievement scores among primary school pupils with dyscalculia taught Mathematics using CRA, Multisensory, and Conventional mathematics instruction, have no significant difference.

Table 8: ANCOVA Comparing Posttest Achievement Across the Three Instructional Conditions (CRA vs. Multisensory vs. Control)

Source of Variation	Sum of Sq. (SS)	(df)	Mean Square (MS)	Fcal	P-value (Sig.)	Decision at $\alpha=0.05$
Pretest (Covariate)	2,110.85	1	2,110.85	25.10	0.000	Significant
Group (Interventions)	18,450.40	2	9,225.20	109.70	0.000	Rejected (H_0)

Source of Variation	Sum of Sq. (SS)	(df)	Mean Square (MS)	Fcal	p-value (Sig.)	Decision at $\alpha=0.05$
Error	12,362.30	147	84.10			
Total	32,923.55	150				

Interpretation: Table 8 shows an overall F_{cal} value of 109.70 with $p = 0.000$. Because $p < 0.05$, the main null hypothesis (H_{04}) is rejected. There is a statistically significant overall difference in posttest mathematics achievement scores among pupils with dyscalculia across the three instructional groups (CRA, Multisensory, and Conventional). Post-hoc paired comparisons confirm that both targeted intervention strategies significantly outperformed the conventional instruction group.

Discussion of Findings

Effect of Concrete–Representational–Abstract (CRA) Instruction on Mathematics Achievement

The findings corresponding to Research Question 1 (Table 1) and Hypothesis 1 (Table 5) revealed that primary school pupils with dyscalculia taught using Concrete–Representational–Abstract (CRA) instruction achieved a substantial mean score increase of 37.25 points, moving from a pretest mean of 31.50 ($SD = 7.82$) to a posttest mean of 68.75 ($SD = 9.14$). ANCOVA analysis confirmed that this achievement gain was statistically significant ($F_{(1,38)} = 48.66, p = 0.000 < 0.05$). Consequently, H_{01} was rejected.

This outcome demonstrates that systematically transitioning dyscalculic learners through three distinct developmental stages—hands-on concrete objects, pictorial representations, and abstract mathematical symbols—effectively grounds abstract numerical concepts in tangible experiences. By allowing pupils to physically manipulate concrete items before introducing abstract notation, CRA provides a scaffold that reduces cognitive load and mitigates mathematical anxiety.

This finding aligns with Jerome Bruner’s Constructivist Theory of Cognitive Development (enactive, iconic, and symbolic stages), which asserts that conceptual understanding develops sequentially. The result also aligns with empirical findings by Yun (2025) and Emma (2025), who noted that CRA instruction bridges the gap between concrete operations and abstract symbolism for struggling learners.

Effect of Multisensory Mathematics Instruction on Mathematics Achievement

Results addressing Research Question 2 (Table 2) and Hypothesis 2 (Table 6) demonstrated that pupils in the Multisensory Mathematics Instruction group recorded a mean score gain of 33.48 points, rising from a pretest mean of 30.87 ($SD = 8.15$) to a posttest mean of 64.35 ($SD = 9.80$). The ANCOVA summary confirmed that this gain was statistically significant ($F_{(1,21)} = 27.95, p = 0.000 < 0.05$), leading to the rejection of H_{02} .

These findings confirm that engaging visual, auditory, tactile, and kinesthetic pathways simultaneously enhances numerical processing and memory retention for learners with dyscalculia. Dyscalculic pupils frequently exhibit deficits in visual-spatial or working memory;

engaging multiple sensory channels allows alternative neural pathways to compensate for specific processing weaknesses.

This finding is supported by Cliff (2025) and Amanda (2025), who emphasized that multi-channel sensory engagement strengthens memory retrieval and supports long-term retention.

Comparative Efficacy of CRA vs. Multisensory Instruction

Data from Research Question 3 (Table 3) and Hypothesis 3 (Table 7) evaluated the relative performance of the two experimental groups. While both interventions yielded notable improvements, pupils taught via CRA instruction achieved a higher posttest mean score (68.75) and mean gain (37.25) compared to those in the Multisensory group (posttest mean = 64.35, mean gain = 33.48), resulting in a net differential mean gain of 3.77 in favor of CRA. ANCOVA testing confirmed that this difference was statistically significant ($F_{(1,60)} = 4.18, p = 0.045 < 0.05$), rejecting H_{03} . This advantage can be attributed to the structured sequence inherent in the CRA model. While multisensory instruction engages multiple senses concurrently, CRA provides an explicit, step-by-step cognitive ladder from physical manipulatives to abstract symbolic representations. For pupils with dyscalculia, this gradual transition may offer greater structure when connecting physical quantities to written numbers.

Overall Difference Across CRA, Multisensory, and Conventional Groups

Research Question 4 (Table 4) and Hypothesis 4 (Table 8) evaluated performance across all three conditions. The CRA group ($n = 40$, mean gain = 37.25) and Multisensory group ($n = 23$, mean gain = 33.48) both outperformed the Control group taught via conventional instruction ($n = 88$, pretest mean = 32.10, posttest mean = 41.20, mean gain = 9.10). ANCOVA results confirmed a statistically significant main effect for instructional strategy across the three conditions ($F_{(2,147)} = 109.70, p = 0.000 < 0.05$), rejecting H_{04} . These results highlight the limitations of traditional, blackboard-heavy, "talk-and-chalk" instruction for dyscalculic learners in public primary schools. Traditional methods rely heavily on rote memorization and immediate symbolic comprehension, which do not provide sufficient scaffolding for pupils with core numerical deficits. In contrast, targeted intervention strategies provide the concrete and multisensory structure required for meaningful mathematical learning.

Conclusion

Based on the empirical findings of this study, traditional, talk-and-chalk instructional practices are largely ineffective for addressing numerical learning deficits in children with dyscalculia. The application of targeted instructional strategies—namely Concrete–Representational–Abstract (CRA) instruction and Multisensory Mathematics Instruction—significantly improves the mathematical achievement of primary school pupils with dyscalculia within Port Harcourt City LGA. Providing physical manipulatives and pictorial representations creates an essential bridge between real-world quantities and abstract numerical symbols. While multisensory approaches foster deep engagement across diverse learning styles, the structured sequential progression of CRA (moving systematically from tangible manipulatives to drawings to abstract digits) offers an exceptionally powerful framework for overcoming specific dyscalculic barriers in resource-constrained classrooms.

Recommendations

1. **Policy Integration & Curriculum Reform:** The Universal Basic Education Board (UBEB) and the Rivers State Ministry of Education should formally integrate structured targeted intervention strategies—specifically the CRA framework—into the primary school mathematics curriculum.
2. **Teacher Professional Development:** Educational authorities should organize continuous workshops and in-service training programs to equip primary school teachers with practical skills in designing and delivering CRA and multisensory mathematics interventions.
3. **Provision of Learning Resources:** School heads and education boards should prioritize providing concrete learning materials, manipulatives (e.g., base-ten blocks, fraction bars, counting rods), and tactile-kinesthetic teaching aids across public primary schools.
4. **Early Screening & Diagnostic Infrastructure:** School administration should establish early screening protocols to identify learners exhibiting dyscalculic characteristics early in their primary education, allowing for timely placement in targeted tier-two intervention groups.

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