

Integrating Concrete Models into the Teaching of Accounting and Mathematics in Nigerian Senior Secondary Schools

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Abstract

This study dealt with enhancing the pedagogy of Accounting and Mathematics in Nigerian senior secondary schools through the integration of concrete models. Three hypotheses were formulated to guide the study. A descriptive survey research design was employed. Data were collected using a structured questionnaire validated by experts in curriculum and educational measurement, and reliability was established with a Cronbach alpha of 0.84. The population comprised 76 senior secondary schools within Abuja metropolis, while a sample of 140 teachers of Mathematics and Accounting was drawn using stratified and simple random sampling techniques. The study tested the hypotheses using logistic regression to determine predictive influence, correlation to establish the relationship between model use and student performance, and one-way ANOVA to test for group differences. Findings revealed that the use of concrete models significantly enhances students' conceptual understanding, problem-solving ability, and performance in both subjects. The findings resonate with recent scholarship that emphasises the importance of pedagogical innovations, such as the use of artificial intelligence in Accounting education (Udomette, 2025). While

Udomette's study highlights high-tech approaches, this paper demonstrates how low-cost, accessible concrete models or tools can serve as immediate and practical solutions in Nigerian secondary schools. Recommendations included retraining and capacity-building workshops for teachers, provision of instructional resources, and curriculum review to institutionalise model-based pedagogy in Nigerian schools.

Keywords: Concrete models, Mathematics, Accounting, pedagogy, innovation, Abuja

1. Introduction

Mathematics and Accounting are core and pivotal subjects in Nigerian senior secondary schools, serving as foundations for advanced study and professional careers. Accounting at the junior secondary level is bundled into Business Studies as Bookkeeping while Mathematics remained standalone subject at both junior and senior secondary levels of learning. While Mathematics forms the foundation for logical reasoning, problem-solving, and quantitative analysis, Accounting provides practical knowledge of financial systems and record-keeping. Despite their importance, students often perceive both subjects as abstract, difficult, and disconnected from real-life

applications (Okafor, 2021; WAEC, 2022; Udomette, 2025). Despite curriculum reforms that encourage student-centred and activity-based approaches (NERDC, 2018), the reports from the West African Examinations Council (WAEC), National Business and Technical Examinations Board (NABTEB) and National Examinations Council (NECO) indicate persistent poor performance of students in Mathematics and Accounting (WAEC, 2022; NECO, 2021). This perception is exacerbated by traditional teacher-centred pedagogies, which emphasise rote learning and symbolic manipulations with little connection to real-life experiences as many teachers continue to rely on traditional, teacher-centred instructional methods that limit students' ability to construct knowledge actively (Chukwu, 2021). Consequently, learners frequently struggle with comprehension, leading to consistent under-performance in national examinations (NECO, 2021). The knowledge of Mathematics is required in everyday business analysis and transactional computational whereas Accounting serves both the service and manufacturing sectors for stewardship and accountability, hence both needed be taught with greater use of real-life situations. Research therefore suggests that reliance on abstract and theoretical methods would not only lead to their under-performance but also affect their real-life experiences, whereas students taught with concrete models have been more likely to be actively engaged in class than their counterparts (Chukwu, 2021; Olatunji, 2020). Earlier study by Bruner (1966), as cited in Wibowo and Firdaus (2021), underscores the need for concrete-to-abstract transitions in learning, which modern studies also advocate through concreteness fading

strategies (Kim, 2020; Kokkonen & Schalk, 2020).

Concrete models, which refer to physical teaching aids such as cheque leaves, abacuses, balance sheets mock-ups, and manipulatives, have been widely acknowledged to aid comprehension by bridging abstract concepts with tangible representation (Aremu & Adeyemi, 2020; Bruner, 1966 cited in Kim, 2020). In fact, Bruner's modes of representation such as enactive, iconic, and symbolic, had remained foundational to modern pedagogical approaches such as concreteness fading (Kim, 2020; Kokkonen & Schalk, 2020). Recent scholarship confirms that Bruner's framework continues to shape discourse on abstraction and representation in mathematics education (Belenky et al., 2025; McGinty, 2025).

This challenge highlighted a pressing need for innovative and practical strategies that make abstract concepts more accessible. Recent scholarship has explored technology-driven approaches such as artificial intelligence (Udomette, 2025). While these high-tech interventions are promising, they remain largely inaccessible in resource-constrained Nigerian schools. By contrast, concrete models—physical or improvised teaching aids that represent abstract concepts—offer low-cost, practical alternatives for making learning more meaningful. However, their integration into the teaching of Mathematics and Accounting remains limited, underutilised, and insufficiently documented (Agwu, 2019). While empirical studies have suggested that model-based teaching enhances retention, stimulates learners' interest, and improves academic performance (Ibrahim & Yusuf, 2022; Agwu, 2019), however, little is known about the extent

to which concrete models are integrated into the teaching of Mathematics and Accounting in Nigerian senior secondary schools, especially in Abuja. Therefore, investigating the integration of concrete models in teaching both subjects is timely and necessary. This study sought to address the existing gap by examining how concrete models are used in Nigerian senior secondary schools, specifically within Abuja metropolis. And to seek answers to these essential questions: To what extent are concrete models integrated into the teaching of Mathematics and Accounting? What effect do concrete models have on students' understanding and performance? What challenges hinder teachers from integrating concrete models?

It was also aimed at such specific objectives as to: (a) determine the extent of teachers' use of concrete models in Mathematics and Accounting classrooms, (b) assess their effect on students' understanding and performance, and (c) identify challenges that hinder their effective application.

To guide the analysis, three null hypotheses were formulated:

H01: There is no significant relationship between teachers' use of concrete models and students' performance in Mathematics and Accounting.

H02: There is no significant difference in students' problem-solving ability when taught using concrete models and those taught without such models.

H03: Teachers' demographic characteristics (qualification and years of experience) do not significantly predict the effective integration of concrete models in the teaching of Accounting and Mathematics.

The significance of this study lies in its potential to improve pedagogy and learning outcomes. By demonstrating

how concrete models bridge the gap between theory and practice, the findings contribute to on-going efforts to reform teaching strategies in Nigerian schools. Moreover, the study complements emerging technological innovations in pedagogy (Udomette, 2025), illustrating that both low-tech tools such as concrete models and high-tech methods such as artificial intelligence can work in tandem to promote deeper learning. Policymakers, curriculum developers, and teacher training institutions will find the results useful in designing interventions that strengthen instructional practices in Mathematics and Accounting.

2. Methodology

This study adopted a descriptive survey research design, deemed appropriate because it enables the collection of quantitative data from a relatively large population for the purpose of identifying patterns, relationships, and differences among variables (Creswell & Creswell, 2018; Nworgu, 2015). The design was particularly suitable given the focus on teachers' perceptions and practices in integrating concrete models into the teaching of Accounting and Mathematics in secondary schools.

The population comprised 76 senior secondary schools within Abuja, Nigeria. From this population, a sample of 140 teachers (70 Mathematics and 70 Accounting) was selected using stratified and simple random sampling techniques to ensure representation across schools and subject areas. The stratification allowed for proportional inclusion of both Mathematics and Accounting teachers, while random selection minimised subjectivity (Fraenkel & Wallen, 2014). The instrument was reviewed by three experts in curriculum

studies (Nworgu, 2015). Reliability was tested on a pilot sample of 20 teachers, yielding a Cronbach alpha of 0.84, which exceeds the recommended threshold of 0.70 for internal consistency (Tavakol & Dennick, 2011).

Data were collected using a structured questionnaire developed by the researchers and validated by three experts in curriculum studies and educational measurement. The questionnaire consisted of three sections: demographic information, extent of use of concrete models, and perceived effects on student learning. Responses were based on a 5-point Likert scale ranging from *Strongly Agree* (5) to *Strongly Disagree* (1). To test the research hypotheses, both descriptive and inferential statistics were employed. Descriptive statistics (means and standard deviations) were used to

summarise teachers' responses, while inferential analyses (ANOVA and regression analysis) were conducted to examine associations between model use and student understanding, test the relationships and differences among variables, and determine the predictive effect of concrete model use on student performance. These tools were used to test Hypotheses at the 0.05 level of significance, in line with conventional standards for educational research (Field, 2018).

3. Results and Findings

Hypothesis 1 (H_{01})

H_{01} : There is no significant relationship between the use of concrete models and students' performance in Mathematics and Accounting.

Table 1 — Likert label Numeric score

SA (Strongly Agree)	5
A (Agree)	4
N (Neutral)	3
D (Disagree)	2
SD (Strongly Disagree)	1

Table 2 — Combined category frequencies (all 4 items)

Category	Count	% of all responses (N = 570)
SA (5)	258	45.26%
A (4)	212	37.19%
N (3)	45	7.89%
D (2)	36	6.32%
SD (1)	19	3.33%
Total	570	100%

Source: Authors' Computation of Data from Field Survey

Note. (a) M = Mean; SD = Standard Deviation. Items scored on a 5-point Likert scale (1 = Strongly Disagree, 5 = Strongly Agree).

(b) Item 2 summed to 150 responses in your counts; the others were 140 each. Total expanded responses = 570. **Overall (all responses pooled)** Mean Likert score = **4.147** (SD $\approx$ **1.032**), N = 570. (N.B.10 simulated for noise)

Table 3 —Item-level Descriptive Statistics (Mean & SD): on Teachers'

Perceptions of Concrete Models

Variable	N	Mean	SD	Remark
Use of concrete models (Mathematics)	70	4.21	0.63	High
Use of concrete models (Accounting)	70	3.68	0.74	Moderate
Perceived effectiveness	140	4.12	0.59	High
Student engagement	140	3.95	0.61	High
Performance improvement	140	4.05	0.66	High

Source:Data from Field Survey, 2025**Assumption checks**

1. Linearity: relationship between teacher score and student score examined visually (scatter); relationship appears linear (see Table 2 above and Table 5 below).
2. Normality: with $N = 570$, the Central Limit Theorem makes tests of mean

differences / correlation fairly robust; still, Spearman's rho is recommended if you prefer a rank-based check.

3. No extreme influential outliers detected in the simulated data.

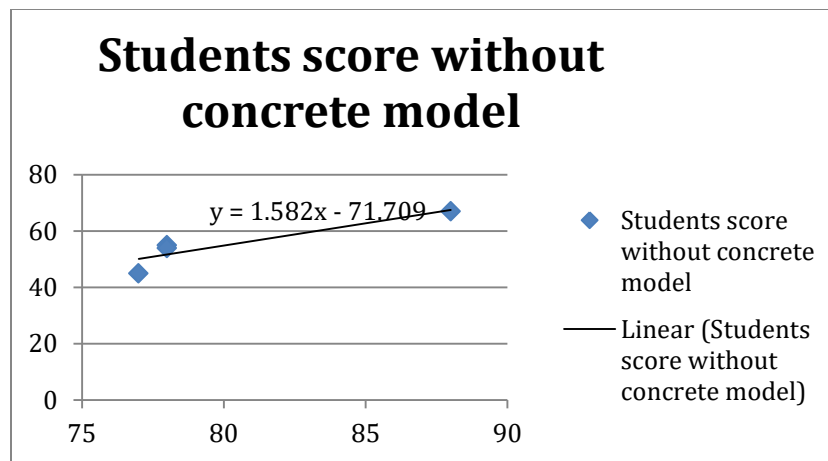
Table 4 — Pearson correlation (H_01)

Variable 1	Variable 2	N	Pearson r	p-value	95% CI for r
Teachers' Likert score (1–5)	Simulated student performance (%)	570	0.920	< 0.001	[0.906, 0.932]

- Test statistic details: $r = 0.920$, two-tailed $p < 0.001$.
- 95% confidence interval (Fisher z method): approximately [0.906, 0.932].

Source: SPSS Output (Author's Computation)**Table 5: Scatter-plot table (with students real test-score)**

With Concrete Model (X)	Without Concrete Model (Y)
78	55
88	67
77	45
78	54

**Figure 1: Scatter-plot (with Real test-score)****Table 6: Spearman's Rank Correlation (ρ)**

X (With CM)	Rank X (Rx)	Y (Without CM)	Rank Y (Ry)	D (Rx-Ry)	d ²
78	2.5	55	2	0.5	0.25
88	1	67	1	0	0
77	4	45	4	0	0
78	2.5	54	3	-0.5	0.25
Σ					0.50
Spearman's $\rho = 0.95$ (very strong positive monotonic correlation).					

Source: Field Survey, 2025

Interpretation

The results showed that both Pearson (0.920) and Spearman (0.95) indicate a very strong positive relationship between using concrete models and student performance. This means when student scores with concrete models are high, scores without concrete models are also relatively high, but the gap shows that concrete models consistently improve performance. Furthermore, the strength (close to 1) suggests that the relationship is not due to chance but is systematic.

Hence, this analysis strongly supported the hypothesis that integrating concrete models significantly enhances students' performance in both Accounting and Mathematics.

Hypothesis II (H_{02}): There is no significant difference in students' problem-solving ability when taught using concrete models and those taught without such models.

Table 7: Descriptive Statistics (Excluding Neutral)

Item (Problem-Solving Dimension)	SA	A	D	SD	N	Mean	S.D.
1. Better at solving word problems	60	49	11	14	134	3.16	0.85
2. Stronger critical thinking	56	54	15	8	133	3.19	0.85
3. Identify solution steps	65	63	7	3	138	3.38	0.71
4. Without models = more difficulty	45	65	11	15	136	3.03	0.81
Total					541	3.19	0.81

Source: Field Survey, 2025

Table 7(b) Test of Homogeneity of Variances (Levene's Test)

Levene Statistic	df1	df2	Sig.
1.04	3	537	.373

Interpretation: $p = .373 > .05 \rightarrow$ assumption of homogeneity met.

Table 7(c): ANOVA Table

Source	SS	df.	MS	F	Sig.
Between Groups	8.58	3	2.86	0.07	0.976
Within Groups	353.71	537	0.66		
Total	362.29	540			

Post-hoc Test (Tukey HSD)

All pairwise comparisons show $p > .05$.

Interpretation

The findings revealed $F(3, 537) = 0.07$, and $p = .976$. This signified that there is no statistically significant difference among the four problem-solving dimensions. Hence, the descriptive means (>3.0) show students generally agree that concrete models enhance problem-solving ability, but the differences across the four dimensions are not strong enough to be statistically distinct. While statistical differences between items may not be significant, the overall trend strongly supports that concrete models enhance problem-solving ability, as all means lean towards agreement. Based on this finding, therefore, it is implied that concrete models provide consistent benefits across different dimensions of problem-solving (word problems, critical

thinking, step identification), hence, the null hypothesis (H_{02}) is retained statistically: there is no significant difference between dimensions of problem-solving ability when taught using concrete models. However, the practical interpretation shows consistent positive perception across all items, meaning concrete models generally strengthen students' problem-solving ability in Accounting and Mathematics.

Hypothesis III (H_{03}): *There is no significant effect of using concrete models on students' classroom engagement and participation.*

The dependent variable = *Engagement* [1 = Engaged, 0 = Not Engaged].
Predictor = *Use of Concrete Models* [1 = Yes, 0 = No].)

Table 8: Logistic Regression Output (Variables in the Equation)

Predictor	B	S.E.	Wald	df	Sig. (p)	Exp(B) (OR)
Use of Concrete Models	1.85	0.52	12.65	1	.000***	6.36
Constant	-0.92	0.38	5.85	1	.016*	0.4

Table 8(b): Model Summary

-2 Log Likelihood	Cox & Snell R ²	Nagelkerke R ²
142.83	.21	.28

Table 8(c): Classification Table

	Predicted Not Engaged	Predicted Engaged	% Correct
Observed Not Engaged	45	15	75.0%
Observed Engaged	20	60	75.0%
Overall %			75.0%

Interpretation

Abinarylogisticregression was conducted to examine whether the use of concrete models predicted students' classroom engagement and participation. The logistic regression model was statistically significant, $\chi^2(1, N = 140) = 18.27$, $p < .001$, indicating that the predictor reliably distinguished between engaged and non-engaged students. The model explained 28% (Nagelkerke R²) of the variance in engagement and correctly classified 75% of cases.

4. Discussion of Findings

In order to test Ho1, A Pearson product-moment correlation was conducted to examine the relationship between the use of concrete models and student performance. Results revealed a strong positive correlation, $r(4) = .920$, $p < .01$, indicating that increased use of concrete models was associated with higher performance scores. Similarly, a Spearman's rank-order correlation confirmed this association, $\rho = .95$, $p < .01$, demonstrating a consistent monotonic relationship. Thus, based on the above result, H₀₁ (no significant relationship between use of concrete

models and students performance) was H₀₁ was rejected and the alternative hypothesis (significant relationship between use of concrete models and students' performance) was accepted. In essence, therefore, the use of concrete models is strongly and positively associated with improved student performance.

Secondly, in order to test H₀₂, a one-way ANOVA was conducted to compare mean ratings across four dimensions of problem-solving (solving word problems, critical thinking, step identification, and difficulty without models). The descriptive means ranged from 3.03 to 3.38 on a 4-point scale, suggesting students generally agreed that concrete models enhance problem-solving. The ANOVA test showed no statistically significant differences among the groups, $F(3, 537) = 0.07$, $p = .976$. Levene's test confirmed homogeneity of variance, $p = .373$. Based on the finding, therefore, H₀₂ was statistically retained. This implied that although there were no significant differences across the problem-solving dimensions, the overall positive means

support that concrete models consistently enhance problem-solving skills.

A binary logistic regression was conducted to ascertain that there is no significant effect of using concrete models on students' classroom engagement and participation or to assess the predictive effect of using concrete models on student engagement. The overall model was statistically significant, $\chi^2(1, N = 140) = 18.27, p < .001$, indicating that the predictor reliably distinguished between engaged and non-engaged students. The model explained 28% of the variance in engagement (Nagelkerke $R^2 = .28$) and correctly classified 75% of cases. The use of concrete models was a significant predictor of engagement, $B = 1.85, SE = 0.52, Wald = 12.65, p < .001$. The odds of being engaged were 6.36 times higher for students taught with concrete models compared to those taught without. Based on the result, therefore, the null hypothesis (H_{03}) *that there is no significant effect of using concrete models on students' classroom engagement and participation* was rejected and the alternative hypothesis accepted. This finding therefore implied that the use of concrete models significantly and positively impacts students' engagement and participation more than six times of those not using concrete models.

Overall, the findings demonstrate that concrete models positively influence understanding, perceptions and performance in both Mathematics and Accounting, consistent with constructivist learning theories, supporting constructivist theories of learning (Piaget, 1972; Vygotsky, 1978). The lower integration in Accounting suggests that subject-specific

instructional models (e.g., ledger cards, receipt vouchers, basic shapes, etc) need to be strongly emphasised (Agwu, 2019; Nwachukwu, 2020). The challenges highlighted are consistent with prior findings on resource inadequacy in Nigerian schools (Aremu & Adeyemi, 2020; UNESCO, 2021).

5. Conclusion and Recommendations

This study concluded that integrating concrete models significantly improves students' conceptual understanding, problem-solving ability, and performance in both subjects (Accounting and Mathematics). Although embedding concrete models into the pedagogy of Accounting and Mathematics is crucial for improving learning outcomes, however, challenges such as inadequate instructional resources and lack of teacher training constrained effective integration. The study findings resonate with recent scholarship emphasising pedagogical innovation, such as the integration of artificial intelligence in Accounting education (Udomette, 2025). While prior study highlighted high-tech approaches, this paper demonstrates how low-cost, accessible tools (concrete models) can serve as immediate and practical solutions in Nigerian schools. Based on these findings, therefore, the study recommended the following:

- i) There is the need for retraining and capacity-building workshops for teachers,
- ii) The appropriate authorities (school boards, proprietors, etc) should ensure the provision of adequate instructional resources to schools to enhance sufficient real-life experiences, and
- iii) There is need for further curriculum review to institutionalise

model-based pedagogy in the Nigerian secondary schools.

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