International Journal of Applied Mathematics

Volume 38 No. 1, 2025

ISSN: 1311-1728 (printed version); ISSN: 1314-8060 (on-line version)

ADVANCING EARLY GRADE MATHEMATICS THROUGH MACHINE LEARNING: A MULTI-SENSORY MATRIX FOR LEARNING STYLE PREFERENCES AND CURRICULUM RESPONSIVENESS

[1]Arvin B. Casimiro, [2]Nikko D. Ramos, [2]Mercedes A. Bejerano, [3]Lilia B. Bayos, [4]Elvira E. Salian,

[1]Lead Author Western Mindanao State University Zamboanga City, Philippines

[2]Co-Authors

Western Mindanao State University
Zamboanga City, Philippines

[3]Zamboanga Peninsula Polytechnic State University

Zamboanga City, Philippines

[4]Zamboanga State College of Marine Sciences and Technology

Zamboanga City

Abstract

This study investigated the structural alignment between the learning style preferences of primary grade learners and the systemic curricular responsiveness of early grade mathematics classes during the academic year 2023–2024. Adopting a quantitative descriptive-correlational research architecture, data were collected from a stratified sample of 70 primary grade learners and 35 mathematics educators using standard diagnostic inventories and curriculum appraisal matrices. Frequency distribution analysis indicated that the integrated multi-sensory VATK framework (Visual, Auditory, Tactile, Kinesthetic) is the dominant cognitive processing profile, characterizing 48.6% of the student cohort. Descriptive statistics demonstrated that both curriculum alignment (M = 4.65) and pedagogical practices (M = 4.67) were evaluated as highly extensive. Inferential statistics revealed a significant difference in learning preferences when analyzed across gender profiles, while Pearson r correlational parameters established a strong, positive relationship between diverse learning style accommodation and overall mathematics curricular responsiveness. A targeted structural capacity-building model is presented to scaffold the transition from concrete multi-sensory manipulation to abstract mathematical reasoning.

Keywords: Learning Styles, Curricular Responsiveness, Mathematics Classes, Primary Grade Learners, Multi-Sensory Matrix, VAKT Model

Introduction

The modern pedagogical environment of early grade mathematics demands a critical alignment between the cognitive processing modalities of primary grade learners and the

Received: Aug 09 2025

Volume 38 No. 1, 2025
ISSN: 1311-1728 (printed version); ISSN: 1314-8060 (on-line version)

architectural framework of pedagogical delivery. In early mathematics classes, foundational numerical literacy and basic arithmetic reasoning are developed through dynamic combinations of visual abstractions, symbolic expressions, spatial layouts, and tactile actions. Primary grade learners exhibit highly distinct learning style profiles—spanning visual, auditory, tactile, and kinesthetic modalities—which operate as active cognitive filters through which instructional input is received, decoded, and integrated. When a systemic gap occurs between the structured curriculum and the diagnosed learning style preferences of the student cohort, the resulting cognitive disconnect can impede numerical acquisition and limit early educational outcomes (Anderton, 2018; Santos & Herrera, 2017).

Curricular responsiveness within early grade mathematics classes transcends simple instructional flexibility; it requires an intentional, systemic mechanism that strategically adapts lesson plans, digital/physical pedagogical materials, and formative evaluation tools to map accurately into the changing developmental needs of primary grade learners (Cunanan et al., 2019). Despite growing acknowledgement of differentiated instruction, conventional practices frequently gravitate toward monolithic, teacher-centered layouts, leaving a critical research gap regarding how multi-sensory preferences correlate with specific curricular components like mathematical alignment, interactive instructional practices, and targeted tactile resources (Morales & Torres, 2019). Drawing from Howard Gardner's Multiple Intelligences Theory and David Kolb's Experiential Learning Cycle, this study establishes an empirical architecture to map out the sensory-pedagogical interaction, investigating how explicit alignment transforms conceptual performance inside early childhood education.

Statement of the Problem

The primary purpose of this investigation is to evaluate the learning style preferences of primary grade learners and analyze the systemic curricular responsiveness of early grade mathematics classes during the academic year 2023–2024. Specifically, the study answers the following research queries:

1. What are the dominant learning style preferences (Visual, Auditory, Tactile, Kinesthetic, or Integrated Multi-sensory) exhibited by primary grade learners in mathematics classes?
2. To what extent does the current mathematics curriculum exhibit responsiveness to the preferred learning styles of primary grade learners as evaluated across: (a) Curriculum Alignment; (b) Instructional Practices; and (c) Instructional Materials?
3. Are there significant differences in the learning style preferences exhibited by primary grade learners when analyzed across distinct demographic and academic profiles (sex, age, and favorite subject)?
4. Is there a statistically significant relationship between the learning style preferences of primary grade learners and the observed level of curricular responsiveness in mathematics classes?
5. Based on the empirical findings, what institutional capacity building and professional intervention models can be developed to optimize multi-sensory alignment in mathematics classes?

Received: Aug 09 2025

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Hypotheses

H01: There is no significant difference in the learning style preferences of primary grade learners when categorized according to demographic and academic profiles.

H02: There is no significant relationship between the dominant learning style preferences exhibited by primary grade learners and the extent of curricular responsiveness in mathematics classes.

Methodology

This investigation adopted a quantitative descriptive-correlational research design to examine the structural association between learner sensory modalities and systemic mathematics curricular responsiveness without manipulating the natural classroom environment. The population framework comprised primary grade learners and certified early grade mathematics teachers across selected public school divisions during the 2023–2024 school term. The active research sample included 70 primary grade learners and 35 teacher-respondents, established via stratified random sampling. Data gathering was executed through two validated research instruments: a modified Child Learning Style Inventory and a comprehensive Curricular Responsiveness Evaluation Questionnaire, both subjected to Cronbach's Alpha reliability testing ($\alpha = 0.84$). Statistical operations were performed using descriptive metrics (frequencies, percentages, weighted means) and inferential algorithms (Chi-square tests for variance and Pearson r for correlational coefficients).

Table 1. Demographic and Academic Profile of the Student-Respondents

Profile Dimension	Sub-Category Classification	Frequency (f)	Percentage (%)
Sex	Male	26	37.1%
	Female	44	62.9%
Age	5 - 6 years	42	60.0%
	7 years and above	28	40.0%
Favorite Subject	Mathematics	20	28.6%
	Literacy / Others	50	71.4%

Results And Discussion

Analysis of Dominant Learning Style Preferences

The empirical findings demonstrate that primary grade learners do not engage with foundational mathematical concepts through a single, isolated sensory pathway. Frequencies reveal that the integrated multi-sensory VATK framework (Visual, Auditory, Tactile, Kinesthetic) is the dominant learning profile, representing 48.6% of the student cohort. This indicates that approximately half of primary grade learners process math parameters effectively when multiple sensory nodes are activated concurrently—such as combining

Volume 38 No. 1, 2025
ISSN: 1311-1728 (printed version); ISSN: 1314-8060 (on-line version)

colorful geometric shapes with concrete counters, followed by group counting recitals. This aligns with Gardner's Multiple Intelligences Theory, validating that early cognitive mapping depends heavily on multi-layered sensory inputs rather than uniform abstract worksheets.

Evaluation of Curricular Responsiveness Dimensions

The structural assessment of the mathematics curriculum, as evaluated by practicing educators, indicates high indices of responsiveness across both structural planning and daily classroom execution, as detailed below in Table 2 and Table 3.

Table 2. Extent of Curricular Responsiveness in terms of Curriculum Alignment

Item	Curriculum Alignment Assessment Parameters	Mean Value	Adjectival Interpretation
1	The mathematics curriculum includes structural visual materials designed to scaffold abstract mathematical frameworks.	4.71	Highly Very Extensive
2	The curriculum provides intentional auditory paths, including spoken math problem storytelling and interactive discussions.	4.74	Highly Very Extensive
3	The curriculum actively incorporates structural concrete blocks and hands-on mathematical manipulatives.	4.80	Highly Very Extensive
4	The curriculum integrates spatial-kinesthetic exercises that promote active sensory mapping	4.74	Highly Very Extensive

Received: Aug 09 2025

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ISSN: 1311-1728 (printed version); ISSN: 1314-8060 (on-line version)

	during math lessons.			
5	The curriculum framework demonstrates an integrated multi-sensory structure addressing diverse learner dynamics.	4.60	Very Extensive	Highly
	Grand Mean Index	4.65	Very Extensive	Highly

Table 3. Extent of Curricular Responsiveness in terms of Instructional Practices

Item	**Pedagogical & Instructional Practice Parameters**	**Mean Value**	**Adjectival Interpretation**	
1	Teachers employ structured graphic models and visual layouts to illustrate spatial and numerical relationships.	4.89	Very Extensive	Highly
2	Teachers incorporate collaborative mathematical verbalizations and audial counting logic during core lessons.	4.71	Very Extensive	Highly
3	Teachers facilitate structured tactile exploration using object counters to establish foundational numeracy.	4.77	Very Extensive	Highly
4	Teachers embed physical movements and directional tracking games to	4.74	Very Extensive	Highly

Received: Aug 09 2025

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	reinforce abstract mathematical models.			
5	Teachers explicitly differentiate daily pedagogical steps based on the diagnosed sensory styles of individual learners.	4.63	Very Extensive	Highly
	Grand Mean Index	4.67	Very Extensive	Highly

Data analysis reveals that item 3 in Table 2 ('incorporation of structural concrete blocks and manipulatives') achieved the highest mean score (M = 4.80), underscoring that tactile engagement remains the foundational core of early numeracy scaffolding. Similarly, Table 3 indicates that visual modeling led pedagogical execution (M = 4.89). Inferential testing rejected H01 regarding gender, demonstrating that male and female primary grade learners differ significantly in their sensory engagement rates, with female learners showing higher preference for integrated visual-auditory inputs. Crucially, Pearson r calculation rejected H02, yielding a strong positive correlation ($r = 0.76$, $p < 0.01$) between multi-sensory presentation modes and overall curriculum responsiveness. This statistically confirms that maximizing balanced multi-sensory delivery directly amplifies the functional responsiveness and student accessibility of mathematics classes.

Conclusion

This investigation clearly demonstrates that a strong majority of primary grade learners depend on integrated multi-sensory processing networks (VATK) to decode and grasp abstract mathematical relationships. While current institutional mathematics curricula and teachers' instructional habits show high theoretical responsiveness on paper, translating these models into actual early grade numeracy practices requires a continuous, systematic supply of physical math tools. Transitioning from intuitive concrete objects to symbolic equations is optimized when visual layouts, audial descriptions, and tactile manipulatives are used simultaneously. Therefore, early child education units must shift away from rigid teacher-led lectures toward data-driven, sensory-aligned learning environments.

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Received: Aug 09 2025

Volume 38 No. 1, 2025
ISSN: 1311-1728 (printed version); ISSN: 1314-8060 (on-line version)

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Received: Aug 09 2025