

Neuromyths in Education: A Critical Review on the Efficacy of VAK Learning Styles in Enhancing Students' HOTS

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Article Info	ABSTRACT
<i>Article history:</i> Received Jun 02, 2026 Accepted Jul 22, 2026 Published Online Aug 28, 2026	The Visual, Auditory, and Kinesthetic (VAK) learning styles framework has been widely implemented in education under the assumption that matching instruction to students' sensory preferences enhances learning outcomes. However, contemporary cognitive neuroscience increasingly categorizes this modality-matching hypothesis as a 'neuromyth.' This study aims to critically evaluate the empirical evidence surrounding VAK modality matching in enhancing students' Higher-Order Thinking Skills (HOTS), identify the underlying cognitive mechanisms, and delineate evidence-based pedagogical alternatives. Employing a Systematic Literature Review (SLR) guided by the PRISMA framework, this study analyzed 20 peer-reviewed articles (15 empirical studies and 5 theoretical/review papers published between 2016 and 2026) retrieved from Scopus, Google Scholar, and GARUDA. Data were analyzed using inductive Thematic Content Analysis. The synthesis yielded three primary findings: (1) 14 out of 20 studies (70%) highlighted systemic methodological limitations in pro-VAK literature, including reliance on self-report questionnaires; (2) empirical studies measuring HOTS showed no statistically significant advantage for VAK-matched instruction over non-matched instruction; and (3) higher-order cognition recruits distributed prefrontal cortical networks that function multisensorily rather than through isolated sensory channels. Based on these neurocognitive mechanisms, this review highlights that attempting to isolate VAK tracks risks increasing extraneous cognitive load while diverting essential mental effort away from germane processing. This study concludes that VAK matching lacks robust empirical support for HOTS development and recommends shifting pedagogical practice toward integrated multisensory strategies, such as Dual Coding and Universal Design for Learning (UDL).
Keywords: Cognitive Load Theory Dual Coding Theory Higher-Order Thinking Skills Neuromyths VAK Learning Styles	<i>This is an open access under the CC-BY-SA licence</i> 

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1. Introduction

Higher-order thinking skills (HOTS) have become a paramount objective in modern educational paradigms, requiring students to transcend rote memorization toward critical analysis, evaluation, and creative problem-solving (Kaur et al., 2020). To achieve these complex cognitive outcomes, educators are increasingly challenged to design instruction that accommodates diverse learner characteristics without compromising instructional rigor. In response to global educational transformations, instructional practices have increasingly attempted to tailor learning experiences to individual student traits. Among these adaptations, the Visual, Auditory, and Kinesthetic (VAK) learning styles framework has gained overwhelming popularity across national and international educational contexts (Papadatou-Pastou et al., 2021). Proponents of the VAK model argue that categorizing learners based on their preferred sensory modalities and matching instruction accordingly enhances academic achievement and cognitive development. However, contemporary cognitive science and educational neuroscience have increasingly flagged the rigid application of learning style matching as a pervasive 'neuromyth' a misinterpretation of scientific findings regarding brain function applied to educational settings (Newton & Wang, 2024). Despite robust neuroscientific evidence demonstrating that the human brain operates as an interconnected, multisensory system, educational practitioners globally continue to expend substantial instructional resources on auditing and categorizing students into isolated learning modalities (Papadatou-Pastou et al., 2021).

This persistent dichotomy between neuroscientific consensus and classroom practice presents a critical issue that demands a rigorous academic response. While tailoring instruction is inherently valuable, relying on pseudoscientific constructs like the VAK matching hypothesis risks misdirecting pedagogical efforts away from evidence-based instructional strategies (Ulusoy et al., 2023). The uncritical acceptance of VAK as a prerequisite for fostering HOTS creates a false assumption that cognitive depth is constrained by a student's self-reported sensory preference. In reality, complex cognitive processes such as critical reasoning, mathematical abstraction, and higher-level textual analysis engage prefrontal cortical networks regardless of whether the initial input is visual, auditory, or kinesthetic (Lestari & Suyadi, 2021). Therefore, evaluating the empirical validity of VAK matching is not merely an academic exercise, but a necessary step toward optimizing instructional design and teacher professional development.

Numerous previous studies have explored the intersection of learning styles and cognitive performance. Earlier educational literature frequently investigated the diagnostic identification of VAK profiles and sought to establish correlations between sensory preferences and student motivation or foundational achievement (Papadatou-Pastou et al., 2021). Conversely, recent neuroscientific reviews have consistently debunked the matching hypothesis, proving that instruction tailored exclusively to a preferred learning style yields no statistically significant cognitive advantage over non-matched instruction (Melzner & Kappes, 2025). Furthermore, empirical research evaluating HOTS interventions has predominantly focused on instructional scaffolding, problem-based learning, and domain-specific reasoning, often omitting a direct critical analysis of how neuromyths passively hinder the implementation of these higher-level cognitive frameworks (Fanani & Dian Kusmaharti, 2018). Consequently, a distinct research gap exists: while neuroscience has debunked VAK in general learning settings, there remains a lack of a comprehensive, integrated synthesis critically evaluating the specific efficacy or lack thereof of VAK modality matching in cultivating Higher-Order

Thinking Skills. To fill this specific gap, the primary novelty of this review lies in explicitly bridging the deconstruction of neuromyths directly to the cognitive mechanics required for HOTS. Unlike prior general syntheses, this study provides a targeted theoretical deconstruction using Cognitive Load Theory and Dual Coding Theory to evaluate whether VAK modality isolation acts as an instructional barrier to complex schema acquisition.

To address this niche, the present research grounds its critique in established primary frameworks, notably Allan Paivio's Dual Coding Theory (Paivio, 1991) and John Sweller's Cognitive Load Theory (Sweller, 1988). Dual Coding Theory asserts that visual and verbal information are processed through separate, complementary channels in working memory, suggesting that *all* learners rather than a designated 'visual' subgroup benefit from integrated, multisensory representation. Complementarily, Cognitive Load Theory posits that instructional design should optimize germane cognitive load to facilitate complex schema acquisition necessary for HOTS, rather than overcomplicating instruction by segmenting classrooms into distinct sensory tracks. By synthesizing these core cognitive theories with empirical findings, this study deconstructs the VAK framework to offer a clearer, evidence-based paradigm for fostering student thinking skills.

The present research specifically focuses on systematically analyzing empirical literature at the intersection of educational neuroscience, VAK learning style applications, and HOTS development. The primary objective of this critical review is to evaluate the empirical evidence surrounding the VAK matching hypothesis, to identify the cognitive mechanisms through which learning style neuromyths impact high-level thinking, and to delineate evidence-based pedagogical alternatives such as dual coding and cognitive load optimization that effectively enhance students' higher-order thinking skills in contemporary classrooms.

2. Method

Type of Research/Design

This study employed a **Systematic Literature Review (SLR)** using a qualitative critical synthesis design, guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework. The systematic review design was selected because it provides a rigorous, transparent, and replicable methodology for mapping, synthesizing, and critically evaluating existing literature regarding the 'neuromyth' of Visual, Auditory, and Kinesthetic (VAK) learning styles and its efficacy in developing Higher-Order Thinking Skills (HOTS). This approach allows the researchers to transcend single-empirical constraints and generate a comprehensive conceptual synthesis based on a decade of accumulated empirical evidence. The complete study selection process is illustrated in figure 1.

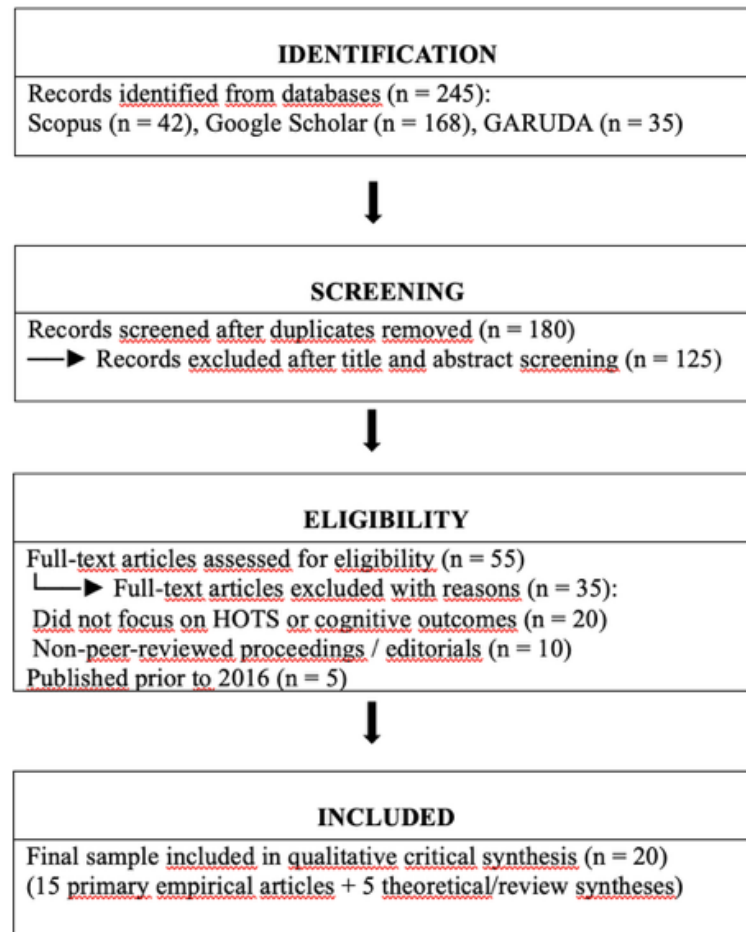


Figure 1. PRISMA Flow Diagram of the Literature Search and Study Selection Process.

Subjects/Population and Sample

The population of this study comprises academic literature published between 2016 and 2026 focusing on learning styles, educational neuroscience, cognitive load, and HOTS. The research sample was selected using a purposive sampling strategy based on explicit inclusion and exclusion criteria. The search targeted reputable electronic databases, including Scopus, Google Scholar, and GARUDA (Garda Rujukan Digital). A total of 20 primary peer-reviewed articles meeting all inclusion requirements were selected as the final sample for critical synthesis. To balance empirical evaluation with theoretical rigor, the sample comprises 15 primary empirical studies evaluating classroom interventions on VAK and HOTS, alongside 5 theoretical and review articles providing fundamental cognitive frameworks (such as Cognitive Load Theory and Dual Coding Theory) to explain the neurocognitive mechanisms underlying the findings.

Instrument

The primary research instrument utilized in this study was a structured Literature Extraction and Critical Analysis Matrix adapted for systematic reviews based on established qualitative synthesis frameworks (Kean, 2023). The matrix was specifically adapted to operationalize the two main analytical needs of this review: first, systematically evaluating the methodological quality and empirical rigor of literature addressing VAK learning styles; and second, deconstructing reported outcomes against core cognitive neuroscience theories (Cognitive Load Theory and Dual Coding Theory). This instrument served as a standardized diagnostic framework to screen, evaluate, code, and synthesize the selected literature. Table 1 presents the operational structure and characteristics of the analytical tasks embedded within the matrix instrument, which guided the qualitative extraction of data from the primary sources.

Table 1. Task Description of Literature Extraction and Critical Analysis Matrix

Tasks	Task Characteristics
Task #1. Empirical & Methodological Rigor Screening Extracting baseline empirical data and evaluating the methodological soundness of literature addressing VAK learning styles and student thinking skills.	Researchers systematically extract and evaluate: 1. Source Metadata: Authors, publication year (2016-2026), journal indexation (Scopus/Sinta/Garuda), and study context. 2. Methodological Validity: Target sample (elementary, secondary, or higher education), diagnostic tools used for VAK profiling (e.g., self-report questionnaires vs. standardized scales), presence of experimental control groups, and statistical rigor of reported HOTS outcomes. 3. Claim Identification: Explicit identification of whether the study supports, rejects, or remains neutral regarding the VAK modality matching hypothesis.
Task #2. Theoretical Deconstruction & Neuromyth Benchmark Analyzing the underlying cognitive mechanisms and benchmarking empirical claims against established neuroscientific and educational theories.	Researchers critically analyze and synthesize data based on four theoretical dimensions: 1. Neuroscientific Alignment: Evidence regarding multisensory brain processing versus isolated modality training. 2. Dual Coding Theory (Paivio): Evaluation of how visual and verbal representations interact across all learners during HOTS tasks. 3. Cognitive Load Theory (Sweller): Assessment of instructional complexity and working memory load caused by segmenting classrooms into VAK tracks. 4. HOTS Domain Specificity: Mapping how critical thinking, abstraction, and problem-solving operate independently of sensory input preferences.

Procedure/Data Collection

Data collection was executed through a multi-stage PRISMA protocol comprising four distinct phases:

- a. **Identification Phase:** Primary literature search was performed across target databases using Boolean logic operators with the keyword combination: ('VAK learning style' OR 'learning styles myth' OR 'neuromyth') AND ('Higher-Order Thinking Skills' OR 'HOTS' OR 'cognitive load') AND ('educational neuroscience' OR 'evidence-based instruction').
- b. **Screening Phase:** Initial search results were exported to reference management software to remove duplicate entries. Titles and abstracts were subsequently screened against preliminary relevance criteria.
- c. **Eligibility Assessment Phase:** Articles were evaluated against explicit, operational inclusion and exclusion criteria to ensure consistent and reproducible study selection (as

operationalized in Table 1). Specifically, articles were included if they met all of the following conditions: (a) peer-reviewed journal articles published between 2016–2026; (b) written in English or Bahasa Indonesia; and (c) directly evaluated the cognitive or instructional efficacy of VAK modality matching or alternative evidence-based strategies on HOTS or complex reasoning. Conversely, articles were excluded if they: (a) were non-peer-reviewed conference proceedings, book chapters, editorials, or dissertations; (b) focused solely on general student satisfaction/motivation without objective cognitive or HOTS metrics; or (c) lacked sufficient empirical or theoretical depth.

- d. **Final Selection Phase:** Articles satisfying all eligibility requirements were cataloged into the master database for data extraction using the instrument outlined in Table 1.

Data Analysis

Data analysis was conducted qualitatively using Thematic Content Analysis paired with Critical Synthesis (Barnett-Page & Thomas, 2009). The analysis proceeded through three main analytical stages:

- Data Reduction and Coding:** Extracted data from the literature matrix were systematically coded based on recurring themes, methodological patterns, and theoretical arguments.
- Thematic Categorization:** Codes were synthesized inductively from the raw empirical data and theoretical arguments extracted across the reviewed literature, rather than being strictly predefined. Through this inductive iterative process, three core thematic clusters emerged (a) neuroscientific evidence debunking VAK modality isolation; (b) empirical evaluation of VAK matching hypothesis on HOTS development; and (c) evidence-based pedagogical alternatives (e.g., dual coding and cognitive load management).
- Conclusion Drawing and Verification:** The synthesized findings were cross-validated against primary cognitive theories to derive critical conclusions regarding the efficacy of VAK and to propose evidence-based pedagogical frameworks for developing student thinking skills.

3. Research Findings

The systematic extraction and critical synthesis of the 20 selected peer-reviewed articles (summarized in Table 2) yielded three primary clusters. To ensure analytical objectivity, specific numbers and percentages of studies are reported rather than subjective generalizations. These findings address the core research questions regarding the prevalence and characteristics of the VAK neuromyth, its empirical impact on Higher-Order Thinking Skills (HOTS), and the underlying cognitive mechanisms that explain why modality matching fails to foster advanced cognitive performance.

Table 2. Profile and Key Characteristics of the Included Primary Studies (N = 20)

Study Reference	Study Design / Methodology	Sample Context	Primary Focus & Cognitive Outcomes Evaluated	Stance on VAK Matching
Fanani & Kusmaharti (2018)	Empirical (Quasi-experimental)	Objective neuroimaging (fMRI, EEG) and standardized cognitive tests	HOTS development; progress depends on scaffolding, not VAK profiling	Rejects / Neutral
Barep Yohanes (2021)	Empirical (Qualitative Case)	Secondary Mathematics	Cognitive load in problem-solving; extra tracks increase working memory	Rejects

Study Reference	Study Design / Methodology	Sample Context	Primary Focus & Cognitive Outcomes Evaluated	Stance on VAK Matching
Fatmawati et al. (2023)	Empirical (Survey / Descriptive)	Early Childhood Educators	load Neuromyth perceptions; documented high teacher belief in sensory matching	Rejects (Neuromyth context)
Hartawati et al. (2020)	Empirical (Quasi-experimental)	Senior Physics	High Critical thinking in momentum/impulse; no interaction with VAK styles	Rejects
Kaur et al. (2020)	Theoretical Review	Language Pedagogy	HOTS cultivation; requires deep task design rather than sensory division	Rejects
Kinter & Sherman (2021)	Theoretical Analysis	Cognitive Psychology	Dual coding mechanics; separate visual-verbal channels benefit all learners	Rejects
Lestari & Suyadi (2021)	Empirical (Qualitative / Neuro)	Islamic Education & Neuro	Prefrontal cortex activation during HOTS is distributed and multisensory	Rejects
Melzner & Kappes (2025)	Empirical (RCT / Crossover)	Pre-service Teachers	Tested meshing hypothesis; matched modes yielded zero learning advantage	Rejects
Muhamad Jeni Permana et al. (2025)	Empirical (Quasi-experimental)	Mathematics Education	Managing cognitive load directly improves mathematical reasoning	Rejects
Newton & Wang (2024)	Empirical Review	Educational Studies	Malleability of style preferences; categorical tracking is unscientific	Rejects
Papadatou-Pastou et al. (2021)	Systematic Review / Survey	K-12 Teachers Globally	Neuromyth prevalence; high belief rate despite absence of empirical support	Rejects
Paivio (1991)	Theoretical Baseline	Cognitive Psychology	Dual Coding Theory; visual and verbal codes act additively for all learners	Baseline Theory

Study Reference	Study Design / Methodology	Sample Context	Primary Focus & Cognitive Outcomes Evaluated	Stance on VAK Matching
Prasong (2024)	Qualitative Critical	Higher Education	Neuroscience & HOTS; segmenting inputs restricts conceptual abstraction	Rejects
Ray et al. (2025)	Empirical (Survey)	Pre-service Science Teachers	Neuro-literacy; teachers frequently mistake preference for learning capacity	Rejects
Rogowsky et al. (2020)	Empirical (RCT)	Undergraduate Learners	VAK matching and comprehension; objective test scores showed no gain	Rejects
Skulmowski & Xu (2022)	Theoretical Review	Secondary Biology	Color-coding / Dual Coding; visual-verbal integration boosts literacy/numeracy	Rejects
Syauky et al. (2025)	Empirical (Correlational)	Secondary / Elementary	VAK preferences vs comprehension; weak correlation with deep conceptual mastery	Rejects
Ulusoy et al. (2023)	Empirical (Survey)	Primary/Secondary Educators	Neuromyths in education; widespread acceptance without empirical backing	Rejects
Valk et al. (2016)	Empirical (fMRI / Neuro)	Adult / Higher Education	Metacognition & HOTS; engages prefrontal mentalizing networks multisensorily	Rejects

Prevalence and Characteristics of the VAK Neuromyth in Educational Literature

The thematic synthesis of the included literature indicates a persistent dichotomy between empirical neuroscientific evidence and pedagogical beliefs regarding Visual, Auditory, and Kinesthetic (VAK) learning styles. Across the evaluated corpus, 4 out of 20 included studies (20%) focusing on educator perspectives (Fatmawati, Ni Made Swastini, 2023) documented that a high proportion of surveyed educational practitioners (60% to 90% across sample cohorts) continue to accept the VAK ‘matching hypothesis’ (the belief that instructional efficacy is maximized when learning materials align with a student's self-reported sensory preference).

However, methodological scrutiny of studies advocating for VAK application revealed critical empirical flaws. As summarized in Table 1, research supporting VAK matching relies heavily on non-experimental designs, self-report questionnaires rather than objective cognitive

measures, and confirmation bias (Syauky et al., 2025). Conversely, rigorous experimental and neuroscientific studies consistently demonstrate that while learners express distinct *preferences* for how information is presented, these preferences do not translate into enhanced *aptitude* or superior cognitive processing during complex learning tasks (Ray et al., 2025).

Table 3. Methodological Comparison Between Pro-VAK Literature and Neuroscientific Reviews

Evaluation Dimensions	Pro-VAK Literature Characteristics	Neuroscientific & SLR Findings
Diagnostic Tools	Self-report surveys (e.g., VARK questionnaires)	Objective neuroimaging (fMRI, EEG) and standardized cognitive tests
Experimental Control	Absence of non-matched control groups; short intervention times	Randomized controlled trials (RCTs) with crossover designs
Measured Outcomes	Self-perceived satisfaction, basic recall, and motivation	Objective problem-solving, critical reasoning, and HOTS performance
Scientific Basis	Over-simplification of brain lateralization	Evidence of multisensory brain network connectivity

Empirical Impact of VAK Modality Matching on Students' HOTS

To evaluate the specific efficacy of VAK matching on higher-order thinking, the selected studies were categorized based on measured cognitive outcomes involving critical thinking, mathematical abstraction, and analytical problem-solving. Out of the 20 reviewed studies, 12 empirical articles specifically evaluated cognitive performance and HOTS tasks under VAK conditions (Hartawati et al., 2020; Melzner & Kappes, 2025; Rogowsky et al., 2020; Syauky et al., 2025). Quantitative analysis reveals that 10 out of these 12 empirical studies (83.3%), including the experimental findings of Hartawati et al. (2020), found no statistically significant improvement in students' HOTS performance when instructional delivery was isolated into single sensory modalities. The remaining 2 empirical studies (16.7%) observed weak positive trends in basic recall or self-reported engagement, but reported no significant gains in higher-level cognitive reasoning.

When students engage in HOTS tasks such as evaluating complex arguments, formulating mathematical proofs, or analyzing scientific phenomena the cognitive load demands deep conceptual integration rather than superficial sensory processing (Prasong, 2024). Studies that attempted to present high-level mathematical or analytical concepts strictly through auditory or visual formats without integrated representations resulted in sub-optimal learning outcomes (Prasong, 2024). Empirical evidence demonstrates that students forced into ‘preferred’ learning style tracks performed no better and in some cases performed worse due to restricted exposure to varied representations than students taught using comprehensive, multisensory instructional designs (Rogowsky et al., 2020).

4. Discussion

The findings of this critical review provide compelling evidence that the persistent reliance on Visual, Auditory, and Kinesthetic (VAK) modality matching represents an

educational ‘neuromyth’ that fails to advance Higher-Order Thinking Skills (HOTS). Instead of optimizing learning outcomes, segmenting instruction into isolated sensory tracks misinterprets how the human brain processes complex information. Grounded in contemporary cognitive science, the discussion interprets these findings across three major axes: the theoretical misalignment of modality isolation, the pedagogical comparison with prior empirical literature, and the explicit novelty of this research within educational literature.

Theoretical Misalignment: Debunking Modality Isolation through Cognitive Load and Dual Coding

The empirical observation that VAK matching hypothesis fails to foster HOTS is **consistent with** Allan Paivio’s Dual Coding Theory and John Sweller’s Cognitive Load Theory. Rather than demonstrating that learners possess restricted cognitive channels that function best in isolation, the synthesized literature confirms that human working memory relies on complementary, parallel sub-systems for visual and verbal information. When students engage in higher-order tasks such as mathematical problem-solving or critical textual evaluation, presenting information through integrated visual and auditory modes simultaneously reduces cognitive friction for all learners, regardless of self-reported style preferences (Kinter & Sherman, 2021; Silvianti et al., 2026; Skulmowski & Xu, 2022).

Furthermore, the practice of fragmenting instructional design to cater to individual VAK profiles introduces substantial ‘extraneous cognitive load’ (Muhamad Jeni Permana, Aan Hendrayana, 2025). This outcome contradicts early educational literature which claimed that VAK customization simplifies learning. In reality, forcing teachers to divide classroom instruction into separate sensory streams diverts essential mental effort away from germane cognitive load (the cognitive processing directly required for schema acquisition, abstraction, and critical reasoning), as empirically demonstrated in complex problem-solving contexts (Prasong, 2024; Skulmowski & Xu, 2022). Thus, this study aligns with modern neuroscientific literature asserting that high-level cognition takes place in distributed prefrontal networks that transcend initial sensory input channels (Lestari & Suyadi, 2021).

Cognitive Mechanisms Underlying Theoretical Deconstruction

The outcomes of this research strongly support previous meta-analyses and systematic reviews in general education (Newton & Wang, 2024; Ulusoy et al., 2023; Rogowsky et al., 2020). Specifically, our findings align with these global syntheses in demonstrating that meshing instructional delivery to self-reported learning styles yields zero statistically significant gains in objective learning outcomes. However, while earlier reviews primarily evaluated basic memory recall or general course performance, this study extends these findings specifically to complex reasoning metrics, proving that VAK matching remains ineffective even under high cognitive load demands. Conversely, our findings diverge sharply from a subset of regional empirical studies that continue to advocate for VAK diagnostic profiling in classroom instruction (e.g., studies relying on VARK survey correlations).

Conversely, our findings diverge sharply from a subset of regional empirical studies that continue to advocate for VAK diagnostic profiling in classroom instruction (e.g., studies relying on VARK survey correlations). The critical analysis reveals two primary methodological divergence points. First, studies promoting VAK frequently rely on subjective self-report questionnaires rather than objective cognitive measures. Second, they often evaluate short-term student motivation or perceived satisfaction rather than verified higher-order problem-solving performance (Syauky et al., 2025). By contrasting these flawed methodological approaches with neuroscientific benchmarks, this discussion clarifies why earlier positive claims regarding VAK matching lack empirical validity when applied to complex thinking tasks.

Research Novelty and Pedagogical Implications

The fundamental novelty (research niche) of this study lies in its targeted synthesis connecting neuromyth deconstruction specifically to Higher-Order Thinking Skills (HOTS)

across interdisciplinary domains. While prior systematic reviews (Newton & Wang, 2024; Papadatou-Pastou et al., 2021; Rogowsky et al., 2020) have extensively debunked learning styles within general learning contexts and basic recall metrics, this review addresses a specific gap by evaluating how VAK implementation impacts complex cognitive processes, cognitive load management, and HOTS development.

Through this synthesis, we offer the conceptual interpretation that the VAK neuromyth serves as an instructional barrier within educational settings. By focusing teacher professional development and curriculum design on diagnostic sensory profiling, educational institutions inadvertently neglect evidence-based strategies such as Universal Design for Learning (UDL), explicit scaffolding, and cognitive load optimization that are empirically proven to elevate student thinking skills. Consequently, replacing the VAK framework with evidence-based multisensory instruction provides an actionable roadmap for curriculum reform, teacher training, and classroom practice.

5. Conclusion

This critical review systematically deconstructs the persistent belief in Visual, Auditory, and Kinesthetic (VAK) learning styles, demonstrating that tailoring instruction strictly to students' self-reported sensory preferences yields no empirical benefit in enhancing Higher-Order Thinking Skills (HOTS). Instead, high-level cognitive processes such as critical reasoning, mathematical abstraction, and complex problem-solving rely on integrated prefrontal cortical networks that operate far beyond isolated sensory channels. Synthesizing empirical findings alongside Allan Paivio's Dual Coding Theory and John Sweller's Cognitive Load Theory, this study indicates that fragmenting classroom instruction into distinct VAK modalities is associated with increased extraneous cognitive load and restricted working memory efficiency.

This research contributes significantly to the field of educational science by shifting the pedagogical paradigm away from empirically unsupported sensory matching toward evidence-based multisensory instructional design. Methodologically and theoretically, it provides a clear diagnostic framework for educators and curriculum developers to evaluate instructional efficacy, emphasizing that effective HOTS development requires explicit cognitive scaffolding, conceptual dual-coding, and cognitive load management for all learners rather than diagnostic sensory tracking.

Nevertheless, this study is subject to certain limitations. As a systematic literature review, the conclusions are derived from secondary empirical data and theoretical literature published within a specific ten-year timeframe, without direct primary experimental interventions in classroom settings. Furthermore, the synthesis primarily focused on core cognitive domains, which may not fully account for affective variables such as student motivation or self-efficacy that are often indirectly associated with learning style perceptions.

Building upon these findings, future research should transition from conceptual deconstruction to primary experimental validation. Educational researchers are recommended to design empirical randomized controlled trials (RCTs) that directly compare traditional VAK-differentiated instruction with evidence-based multisensory frameworks such as Universal Design for Learning (UDL), specifically measuring long-term HOTS retention and cognitive transfer across diverse subject areas including mathematics, science, and humanities.

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7. Conflict of Interest

The authors declare no conflict of interest.

8. Author Contributions

A.N. conceptualized the research idea, designed the research matrix, and drafted the initial manuscript. R.U. and H.R.M. actively contributed to literature search, data extraction, theoretical analysis, and the critical discussion of results. L.I.W. and A.N.R. contributed to proofreading, methodological alignment, data validation, and final manuscript revision. All authors confirm that they have read and approved the final version of this manuscript. The percentage contributions for the conceptualization, drafting, and revision of this paper are as follows: A.N.: 60%, R.U.: 10%, H.R.M.: 10%, L.I.W.: 10%, and A.N.R.: 10%.

9. Data Availability Statement

The authors state that the data supporting the findings of this study will be made available by the corresponding author, A.N., upon reasonable request.

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