Design Strategy for Multisensory Education Products: A Conceptual Approach

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ABSTRACT

This study addresses the lack of explicit design-strategy guidance in the development of multisensory education products. Although multisensory approaches are widely recognised for enhancing engagement and learning, existing research primarily emphasises instructional outcomes rather than product-level design configuration. The aim of this conceptual paper is to develop a structured design-strategy framework that clarifies how sensory modalities should be selected, prioritised, sequenced, and integrated within children's education products. Adopting a theory-driven conceptual approach, the study synthesises literature across industrial design, embodied cognition, cognitive load theory, and sensory congruency research. The paper proposes a hierarchical conceptual framework linking theoretical foundations, strategic domains, product design dimensions, experiential outcomes, and educational impact. By positioning multisensory engagement as a strategic configuration problem, this study contributes a clearer conceptual foundation for coherent and inclusive education product design.

Keywords — Multisensory Design, Education Product Design, Design Strategy, Product Experience, Embodied Interaction

INTRODUCTION

Across education systems worldwide, concerns about foundational learning have intensified as evidence point to persistent gaps in basic reading and numeracy and, in many contexts, declining performance. Recent global monitoring highlights that a substantial proportion of children are not attaining foundational competencies, with learning poverty remaining a central indicator of the learning crisis and its long-term social and economic consequences (Hempel Foundation, 2025). At the same time, international assessment trends report notable declines in key domains such as reading and mathematics in the most recent PISA cycle, reinforcing the urgency of strengthening early learning experiences and the quality of learning supports (OECD, 2023). These conditions have renewed attention on the role of learning materials and education products, not merely as instructional supplements, but as designed artefacts that shape attention, engagement, and access to core learning tasks.

Within this broader context, education products (for example, manipulatives, hybrid physical–digital kits, sensory books, and interactive learning tools) have expanded in variety and technological sophistication. A growing body of work suggests that combining physical and digital elements can enrich learning materials and support engagement and interaction, particularly when design features are thoughtfully aligned to users' capabilities and contexts of use (Di Fuccio et al., 2025). However, increased functionality can also introduce complexity, fragmented interactions, or overstimulation when sensory inputs are layered without a coherent design strategy.

Multisensory approaches are frequently proposed as a means of enhancing learning experiences by engaging multiple sensory channels, such as visual, tactile, auditory, and kinesthetic interaction, while supporting diverse learner needs. Recent studies and reviews continue to report sustained interest in multisensory educational materials and hybrid interventions, including work on multisensory books and digitally augmented learning resources (Xin et al., 2026). Yet, much of this discourse remains centred on educational outcomes or instructional methods, rather than on the product-design logic that determines how sensory cues are selected, prioritised, sequenced, and constrained within the artefact itself.

This gap presents a clear opportunity for industrial design scholarship. While multisensory interaction has been widely discussed within human–computer interaction and systems design, its translation into industrial design strategy for education products remains under-specified, particularly in relation to actionable design decisions concerning form, materiality, interaction architecture, and information hierarchy (Qi et al., 2024). In practice, multisensory features are often adopted as additive enhancements rather than as components of an integrated strategy, which may lead to inconsistent affordances, competing sensory signals, and avoidable cognitive burden for learners and facilitators.

Accordingly, this conceptual paper advances a design-strategy perspective on multisensory education products. It argues that multisensory design should be treated as a strategic configuration problem, in which sensory channels are intentionally orchestrated to support clarity of action, sustained engagement, and usability across varied learning contexts, rather than treated as a checklist of sensory features. The contribution of this paper lies in consolidating and reframing multisensory education through industrial design concerns, thereby establishing a foundation for more consistent design decision-making and future empirical validation within education product development.

In the Malaysian context, the need for strategically designed multisensory education products is underscored by patterns of disability registration and participation in special education provision. In 2024, Malaysia recorded 805,509 registered persons with disabilities (2.4 per cent of the population), with learning disabilities constituting 299,128 individuals or 37.1 per cent of total registrations (DOSM, 2024). Within the schooling system, parliamentary records report 107,020 *Murid Berkeperluan Pendidikan Khas (MBPK)* as of 31 January 2023 (Parliament of Malaysia, 2023). Additional statistics indicate 34 special education schools nationwide, supported by dedicated primary and secondary teachers (DOSM, 2024). These figures reflect substantial demand for inclusive and structured learning support environments.

At the policy level, the Ministry of Education Malaysia emphasises student-centred learning and structured support for special education. Curriculum documentation frames classroom instruction as student-centred, including within Design and Technology (*Reka Bentuk dan Teknologi, RBT*) under the *KSSR Semakan* 2017 curriculum (MOE, 2018). The Ministry's operating guidelines for Special Education Support Centres further specify dedicated multisensory facilities (MOE, 2025). Collectively, these initiatives signal a national orientation toward experiential and inclusive learning environments aligned with multisensory principles.

Empirical studies in Malaysia reinforce this direction while highlighting the need for clearer design-strategy guidance. Reviews of dyslexia interventions consistently identify multisensory methods as core approaches (Yuzaidey et al., 2018), and structured phonics programmes demonstrate local adaptation of multisensory principles within Bahasa Melayu contexts (Lee & Lee, 2021). Early childhood research similarly reports benefits of multisensory engagement in numeracy development (Lee Mei & Kamariah, 2022). However, qualitative evidence from special education settings indicates ongoing implementation challenges, suggesting that multisensory concepts do not automatically translate into consistent, classroom-ready solutions without clearer design-level operational models (Lim et al., 2022).

Despite sustained interest in multisensory approaches, a research gap remains at the level of industrial design strategy. Existing studies predominantly address instructional or intervention outcomes, offering limited insight into how sensory modalities should be selected, prioritised, sequenced, and integrated within the physical and interactive architecture of education products. Without a coherent strategy, multisensory features risk being applied in an additive or ad hoc manner, potentially resulting in fragmented affordances and competing sensory cues. Accordingly, this study develops a conceptual design-strategy framework that clarifies how multisensory engagement can be systematically configured within education product development.

This paper is structured as follows. The next section synthesises key theoretical perspectives on multisensory

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interaction and design strategy. This is followed by conceptual analysis leading to the articulation of the proposed framework. The subsequent section discusses implications for industrial design practice and future research before outlining study limitations and directions for empirical validation.

LITERATURE REVIEW

Product experience as a lens for multisensory design in children's learning products

In industrial design, multisensory product design is best understood through the concept of product experience, because the value of sensory features is realised through what children perceive, feel, and do when interacting with an artefact. Desmet and Hekkert's framework remains influential in clarifying product experience as a multi-layered phenomenon that includes aesthetic experience, experience of meaning, and emotional experience that arise during human–product interaction (Desmet & Hekkert, 2007). For children's learning products, this framing is particularly useful because sensory engagement is not peripheral to function; it often constitutes the interface through which exploration, attention, and meaning-making occur. Tactile textures, kinesthetic actions, and audiovisual cues influence not only immediate usability but also the affective tone of the interaction, including curiosity, confidence, and willingness to persist with a task.

Recent work on children's learning artefacts reinforces that multisensory features become productive when they are aligned with children's developmental capabilities and the social setting of use (classroom routines, peer interaction, adult facilitation). For example, studies on digital manipulatives for young children show that the experience is shaped by how behaviours are "designed-in" to objects and how interactions support child-led exploration and shared meaning-making, rather than by the mere presence of embedded technology (Matthews et al., 2025). Similarly, tangible learning tools and TUIs are repeatedly described as novice-friendly and conducive to engagement because they externalise abstract concepts into physically graspable actions (Liang et al., 2021). From a product-experience perspective, these findings imply that multisensory education products should be evaluated not only for their instructional intent but also for their experiential coherence: whether sensory cues reinforce one another, whether the artefact communicates "what to do next," and whether the overall interaction supports positive affect without introducing unnecessary distraction.

A second implication concerns sensory congruency. Multisensory experiences can be coherent or conflicting depending on how sensory cues relate across modalities. Research on crossmodal correspondences shows that people (including preschool children) exhibit systematic associations between features such as shape, colour, sound, and affect, and these associations can influence perception and preference (Meng et al., 2023). For children's learning products, congruency matters because it can reduce interpretive effort: if tactile, visual, and auditory cues "tell the same story," the product experience becomes clearer and more intuitive; if cues compete, children may attend to salient but irrelevant stimuli. In this sense, product experience provides an organising lens for multisensory design strategy by connecting sensory choices to attention, meaning, and emotion within situated interaction.

Theoretical and model foundations for multisensory education product design strategy

Product Experience Framework (Desmet & Hekkert). This remains the most direct design-theory anchor for explaining how sensory, interpretive, and emotional responses form an integrated experience in human–product interaction, providing a scaffold for linking multisensory design decisions to experiential outcomes.

Embodied cognition and learning with manipulatives. Embodied accounts argue that cognition is shaped by perception–action loops and that physical interaction can support understanding by grounding abstract ideas in bodily action. This is highly relevant for children's learning products because interaction is often kinaesthetic and object-centred. Evidence syntheses in embodied and visuospatial learning highlight how physical objects and movement-based engagement can support understanding, while also noting that design must manage the relation between concrete action and abstraction (Fadhla et al., 2024).

Cognitive Load Theory (CLT) as a constraint model for multisensory features. Multisensory product design for learning must address the risk that perceptual richness becomes distracting. Reviews of learning with manipulatives explicitly note that perceptual and interactive richness can impose additional load and hinder abstraction if not carefully designed and scaffolded (Pouw et al., 2014). CLT functions as a theoretical constraint, reinforcing the need to prioritise and sequence sensory cues rather than merely adding channels.

Universal Design for Learning (UDL) is widely recognised as an inclusion-oriented framework that emphasises addressing learner variability through multiple means of representation, action or expression, and engagement. Ongoing developments and applications of the UDL framework have strengthened its relevance in contemporary educational contexts by emphasising flexibility, learner choice, and the reduction of participation barriers. Although UDL is most commonly applied at the curriculum and instructional design levels, its underlying principles offer conceptual implications for the design of learning artefacts and educational tools, particularly in terms of adaptability, interaction diversity, and inclusive user experiences. This conceptual perspective is especially relevant for children with diverse sensory and attentional profiles, who benefit from multisensory and flexible learning interactions (Yuege & Zaharudin, 2025).

Multisensory interaction frameworks within the field of human–computer interaction (HCI) provide a useful conceptual language for describing multisensory systems as configurations of sensory modalities and for addressing integration challenges such as synchronization, coordination, and cross-modal interaction. Contemporary HCI literature highlights the need for design frameworks that move beyond visually dominated interaction models to systematically incorporate touch, taste, and smell within interactive systems. For an industrial design conceptual approach, such frameworks can be selectively drawn upon to articulate how multisensory elements are orchestrated at the product level, while product experience theory provides the rationale for why such orchestration matters from a design perspective (Obrist et al., 2017)

Together, these foundations support a coherent conceptual stance in which product experience explains the intended experiential target, embodied cognition clarifies why tangible multisensory action is meaningful for children, cognitive load theory constrains sensory richness to prevent overload, Universal Design for Learning strengthens inclusivity, and multisensory interaction frameworks offer a shared vocabulary for integration and coherence.

Research Gaps and Synthesis

Recent studies indicate that multisensory artefacts can enhance engagement and exploratory interaction in children's learning contexts, particularly when tangible manipulation supports embodied interaction (Liang et al., 2021; Matthews et al., 2025). A comparative study of multisensory and traditional toys further reports higher engagement time and greater learning improvement under multisensory conditions, underscoring the potential of integrated sensory design in children's educational products (Fan et al., 2024). While these findings provide empirical support for multisensory approaches, the existing literature remains predominantly outcome-oriented. Limited attention has been given to how sensory modalities should be strategically configured within the product itself.

In particular, current research rarely articulates design-level principles for selecting, prioritising, and integrating visual, tactile, auditory, and kinaesthetic cues in children's learning products. Studies on embodied interaction and the use of manipulatives caution that perceptual richness may either facilitate or hinder abstraction depending on how interactions are structured (Fyfe et al., 2014; Nathan & Walkington, 2017). However, such insights are seldom translated into actionable strategies for product development. Similarly, research on crossmodal correspondences demonstrates that sensory congruency influences perception and affect (Spence, 2011), yet these findings have not been systematically operationalised into coherent frameworks for education product design.

As contemporary learning artefacts increasingly integrate physical and digital components, multisensory elements now extend across material properties, interface behaviours, embedded feedback systems, and spatial interaction. Despite this growing complexity, industrial design scholarship offers limited strategic guidance for coordinating these layers into a unified product experience. As a result, multisensory features are often introduced as additive enhancements rather than as components of a deliberate and integrated design strategy.

Taken together, the literature suggests that the central unresolved issue is not whether multisensory engagement is beneficial, but how it should be strategically designed within education products. Addressing this gap requires a conceptual approach that frames multisensory engagement in terms of design configuration, integration logic, and product experience coherence, rather than sensory enrichment alone.

Table 1

Author(s)	Year	Title	Methodology	Key Findings
Fan, Chong & Li	2024	Beyond play: a comparative study of multi-sensory and traditional toys in child education.	Systematic review + pilot quasi-experimental study with children aged 3–6; engagement metrics, pre/post tests, observation	Multisensory toys produced higher engagement time and greater short-term learning gains than traditional toys; highlights need for design attention to individual differences and contextual factors.
Matthews, S.	2025	Designing digital manipulatives for young children.	Empirical preschool study of “digital manipulatives” (Embeddables); observational and design analysis	Shows that carefully designed object behaviours and embedded feedback support child-led exploration and social interaction in preschool settings; emphasises behaviour design over added features.
Lee-Cultura et al.	2022	Children’s play and problem-solving in motion-based learning technologies.	Empirical/field studies of motion-based systems	Motion and embodied interactions boost engagement and problem-solving but require careful scaffolding to avoid distraction and to promote transfer.
Farra, N. K. A.	2024	Impact of virtual and concrete manipulatives on teaching fractions.	Quasi-experimental classroom study comparing virtual vs concrete manipulatives	Concrete (physical or hybrid) manipulatives often aid comprehension and retention when aligned with task structure; modality alone is not sufficient—design of mapping between action and abstraction matters.
Meng et al.	2023	Crossmodal correspondences between visual features and tastes (children).	Experimental study of crossmodal correspondences in children	Children show developmental differences in crossmodal mappings; sensory congruency influences perception and preference, suggesting designers must consider learned and age-dependent correspondences.

As shown in **Table 1**, recent studies indicate that multisensory design in children’s learning products can increase engagement and improve short-term learning outcomes. A comparative study found that children using multisensory toys demonstrated higher engagement time and greater learning improvement than those using traditional toys (Fan et al., 2024). Research on digital manipulatives similarly shows that well-designed interaction behaviours support exploration and collaborative learning (Matthews, 2025).

Other studies highlight that embodied and motion-based interaction can enhance problem-solving when sensory input is clearly aligned with learning objectives (Lee-Cultura et al., 2022). Comparisons between virtual and concrete manipulatives also suggest that physical or hybrid artefacts support conceptual understanding when action and abstraction are carefully structured through design (Farra, 2024).

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In addition, research on crossmodal correspondences shows that sensory congruency influences children's perception and emotional response (Meng et al., 2023). Overall, while multisensory products show positive effects, existing research focuses mainly on outcomes rather than on design principles. There remains limited guidance on how sensory modalities should be selected, prioritised, and integrated within children's learning products. This gap supports the need for a clearer design-strategy framework for multisensory education products.

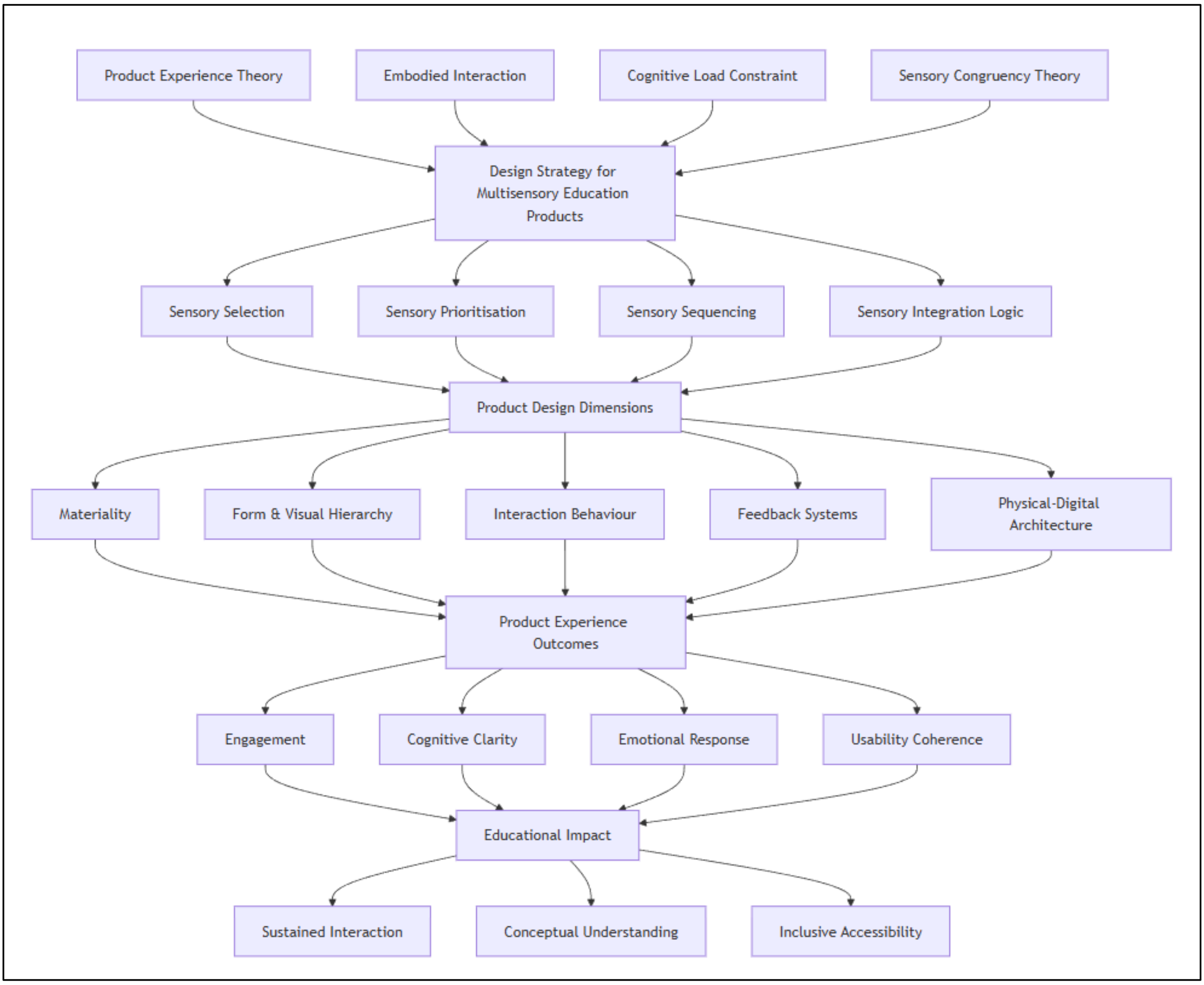

Fig.1. Conceptual Framework Diagram

Figure 1 presents the conceptual framework for a design strategy approach to multisensory education products. The framework positions design strategy at the centre, informed by product experience theory, embodied interaction, cognitive load constraints, and sensory congruency research. These theoretical perspectives provide the conceptual foundation that shapes multisensory decision-making. Within the framework, design strategy is articulated through four interrelated domains: sensory selection, prioritisation, sequencing, and integration logic. These domains guide how multisensory elements are configured rather than merely added.

The strategy informs key product design dimensions, including materiality, form and visual hierarchy, interaction behaviour, feedback systems, and physical–digital architecture. The configuration of these design dimensions influences product experience outcomes, namely engagement, cognitive clarity, emotional response, and usability coherence. These experiential outcomes collectively contribute to broader educational impact, reflected in sustained interaction, conceptual understanding, and inclusive accessibility. The framework therefore illustrates how multisensory engagement operates as a structured design configuration process linking

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theory, product attributes, and educational consequences.

Operational Interpretation of Strategic Domains

To enhance the practical interpretability of the proposed framework, the four strategic domains can be translated into guiding design questions and example decision criteria, as shown in **Table 2**. While the framework remains conceptual, these interpretations illustrate how multisensory configuration may be operationalised within education product development.

Table 2

Strategic Domain	**Guiding Design Question**	**Example Operational Consideration**
Sensory Selection	Which sensory channels directly support the learning objective?	Align modality with cognitive task (e.g., tactile for letter tracing; auditory for phonemic awareness). Avoid adding channels that do not reinforce task clarity.
Sensory Prioritisation	Which channel should be primary, and which should be supportive?	Define a dominant sensory pathway (e.g., visual-textual core) while using secondary cues (sound, texture) as reinforcement rather than distraction.
Sensory Sequencing	In what order should sensory inputs be introduced?	Introduce concrete tactile interaction before abstract visual representation to scaffold understanding. Avoid simultaneous overload of multiple cues.
Sensory Integration Logic	Do sensory elements reinforce or compete with one another?	Evaluate congruency across colour, sound, movement, and texture to ensure coherence. Remove conflicting cues that increase cognitive load.

Illustrative Application Scenario

To illustrate how the framework may guide practical design decisions, consider a multisensory phonics learning kit for early readers. Using the strategic domains, sensory selection would prioritise tactile letter tracing and auditory phoneme feedback as primary channels directly aligned with decoding objectives. Sensory prioritisation would designate tactile interaction as the dominant pathway, while auditory cues function as reinforcement rather than simultaneous stimulation. Sensory sequencing would introduce concrete tactile tracing before abstract visual-symbol recognition to scaffold understanding. Integration logic would ensure that colour, texture, and sound cues reinforce phoneme–grapheme mapping rather than compete for attention. Through this configuration, the product experience aims to sustain engagement while maintaining cognitive clarity and coherence.

METHODOLOGY

Research Design and Conceptual Approach

This study adopts a theory-driven conceptual research design to develop a structured design strategy framework for multisensory education products. Unlike empirical studies that test hypotheses through experimentation or field data, conceptual research seeks to clarify constructs, examine theoretical relationships, and advance knowledge through analytical reasoning and synthesis. The present study is therefore non-empirical in nature and focuses on theory integration rather than data collection.

The conceptual approach is grounded in industrial design scholarship and draws upon interdisciplinary theoretical perspectives, including product experience theory, embodied interaction, cognitive load theory, and crossmodal correspondence research. These perspectives are examined to address the research objective: to articulate how multisensory engagement can be strategically configured within children's education products

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rather than treated as an additive feature. The study positions multisensory design as a configuration problem involving selection, prioritisation, sequencing, and integration of sensory modalities at the product level.

Literature Identification and Selection Process

A structured literature identification process was conducted to ensure comprehensive coverage of relevant scholarship. Academic sources were searched through major scholarly databases including Scopus, Web of Science, ScienceDirect, SpringerLink, and Google Scholar. Keywords included combinations of multisensory design, multisensory learning products, tangible interaction, digital manipulatives, embodied interaction, crossmodal correspondences, product experience, and children’s educational toys.

Priority was given to peer-reviewed journal articles published within the past five years to ensure currency, particularly in high-impact journals in industrial design, human–computer interaction, child–computer interaction, and educational technology. Foundational theoretical works were included where necessary to establish conceptual grounding.

The literature identification process was guided by conceptual relevance rather than exhaustive systematic enumeration. A total of 27 core peer-reviewed and foundational sources were retained for conceptual synthesis based on their direct contribution to understanding sensory configuration, experiential coherence, and design-strategy development. These sources formed the analytical foundation for the development of the proposed conceptual framework.

The screening process involved three stages. First, titles and abstracts were reviewed to assess conceptual relevance to multisensory product design rather than general pedagogy. Second, full-text articles were evaluated to determine their contribution to understanding sensory integration, product interaction, or design strategy. Third, selected sources were categorised according to their primary focus, including theoretical foundations, empirical validation, perceptual studies, and interaction design research. Only literature that directly informed multisensory configuration, embodied interaction, or product experience was retained for analysis.

Conceptual Analysis and Synthesis

The conceptual analysis followed an integrative and comparative process. Key constructs were first extracted from the selected literature, including sensory modality selection, embodied manipulation, perceptual congruency, interaction behaviour, feedback systems, and cognitive load constraints. These constructs were then examined across theoretical traditions to identify areas of convergence, tension, and complementarity.

Comparative analysis was used to explore how different theoretical perspectives addressed multisensory interaction at varying levels, ranging from perceptual processing to product-level design decisions. For example, cognitive load theory provided constraints on sensory richness, while embodied cognition highlighted the value of tangible interaction. Crossmodal correspondence research informed principles of sensory congruency, and product experience theory clarified experiential outcomes.

Through iterative comparison and abstraction, overlapping themes were consolidated into higher-order conceptual categories. This synthesis process allowed the study to move beyond descriptive reporting and toward theory building. The analysis focused on identifying structural relationships among constructs rather than summarising empirical outcomes, ensuring alignment with the conceptual objectives of the study.

Conceptual Framework Development

The conceptual framework was developed through a structured synthesis of the analysed literature. Following construct identification and thematic comparison, related concepts were grouped and organised into hierarchical layers according to their explanatory role. Theoretical constructs were positioned at the foundational level, followed by a central strategic construct that translates theory into decision domains. These decision domains were then linked to tangible product design dimensions, which were subsequently connected to experiential and educational consequences. The relationships among components were established through iterative comparison of theoretical arguments and empirical insights. Constructs were retained only where consistent support was identified across multiple sources. Directional relationships were mapped to reflect logical progression from foundational theory to design strategy, from strategy to implementation dimensions, and from implementation to experiential and educational outcomes.

More specifically, the theoretical foundations function as explanatory mechanisms that inform strategic reasoning at the design level. The strategic domains of sensory selection, prioritisation, sequencing, and integration shape concrete product design dimensions by guiding decisions related to materiality, interaction behaviour, feedback systems, and physical–digital architecture. These design dimensions generate identifiable product experience outcomes, including engagement, cognitive clarity, emotional response, and usability coherence. Experiential outcomes subsequently influence broader educational impact. This directional structure clarifies that multisensory engagement emerges from aligned theoretical reasoning, strategic configuration, and implementation logic rather than from isolated sensory features.

This process ensured structural coherence in the resulting framework.

DISCUSSION

This study highlights the importance of treating multisensory design as a structured strategy rather than as the simple addition of sensory features in children's education products. The literature consistently indicates that multisensory interaction enhances engagement and supports learning when sensory elements are coherently organised and aligned with instructional goals. However, existing research often focuses on learning outcomes without clearly explaining how sensory modalities should be configured at the product design level.

By integrating product experience theory, embodied interaction, cognitive load considerations, and sensory congruency research, this paper proposes a conceptual framework that links theoretical foundations to design strategy and practical implementation. The framework clarifies how sensory selection, prioritisation, sequencing, and integration can guide material, interaction, and feedback decisions to produce coherent product experiences and meaningful educational impact.

The contribution of this study lies in offering a clearer design-oriented perspective on multisensory education products. It provides a structured reference for designers and researchers seeking to develop products that balance engagement, cognitive clarity, and inclusivity.

While multisensory design offers enhanced engagement and inclusivity, it also introduces strategic tensions that require deliberate evaluation. One key tension concerns sensory richness versus cognitive load. Although additional sensory channels may increase stimulation and interest, excessive or poorly coordinated inputs can impose extraneous cognitive burden, potentially undermining clarity and abstraction. A second tension arises between engagement and distraction, particularly in hybrid physical–digital artefacts where audiovisual feedback may compete with task-relevant cues. Designers must therefore assess whether sensory elements reinforce instructional intent or merely amplify surface-level stimulation. A third tension involves flexibility versus coherence. While inclusive design encourages multiple pathways of interaction, excessive variability may dilute perceptual consistency and experiential stability. Addressing these tensions requires prioritisation and integration logic that aligns sensory configuration with learning objectives and user capability.

Nevertheless, this study is conceptual in nature and does not include empirical validation. Future research should test the proposed framework through prototype development, user studies, and comparative evaluations across different learning contexts. Such validation would strengthen its applicability and refine its strategic principles.

Overall, the proposed framework contributes to a clearer and more systematic understanding of multisensory education product development, offering structured guidance for coherent and inclusive design practice.

REFERENCES

1. Ali, N. (2022, April 20). A Multi-Sensory Teaching Aid Of Malay Language For Dyslexic Children.

https://doi.org/10.4108/eai.24-8-2021.2315043

2. Department of Statistics Malaysia. (2024). PERSON WITH DISABILITY STATISTICS, MALAYSIA, 2024. https://www.dosm.gov.my/portal-main/release-content/person-with-disability-statistics-malaysia-2024
3. Desmet, P., & Hekkert, P. (2007). Framework of Product Experience Human-Product Interaction. International Journal of Design, 13–23. www.ijdesign.org
4. Di Fuccio, R., Ponticorvo, M., Nadim, M. A., & Limone, P. (2025). Exploring the effect of digital and multisensory educational materials on retention in primary school using Tangible User Interfaces, Interactive Learning Environments. Interactive Learning Environments, 33(4), 2928–2938. https://doi.org/10.1080/10494820.2024.2427277
5. Fadhla, M., Junus, B., & Bennett, J. A. (2024). Visuospatial and Embodied Cognition in STEM Education: A Systematic Literature Review. The Future of Engineering Education.
6. Fan, Y., Chong, D. K., & Li, Y. (2024). Beyond Play: A Comparative Study of Multi-sensory and Traditional Toys in Child Education. In Frontiers in Education (Vol. 9). Frontiers Media SA. https://doi.org/10.3389/feduc.2024.1182660
7. Fyfe, E. R., McNeil, N. M., Son, J. Y., & Goldstone, R. L. (2014). Concreteness Fading in Mathematics and Science Instruction: A Systematic Review. In Educational Psychology Review (Vol. 26, Number 1, pp. 9–25). Springer Science and Business Media, LLC. https://doi.org/10.1007/s10648-014-9249-3
8. Hempel Foundation, the. (2025). Foundation First: Insights from the Global Foundational Learning Action Tracker 2025.
9. Lee, A. S. S., & Lee, L. W. (2021). Effect of a Malay Language Phonics Intervention on the Decoding Skills and Self-regulated Learning Strategies of Older Primary School Students with Dyslexia. Kajian Malaysia, 39(1), 77–98. https://doi.org/10.21315/KM2021.39.1.4
10. Lee Mei, C., & Kamariah, A. B. (2022). Effective Use of Multisensory Approach in Improving Number Concept Skills Among Pre-Schoolers. Jurnal Pendidikan Bitara UPSI, (15), 53–61. https://doi.org/10.37134/bitara.vol15.sp.6.2022
11. Lee-Cultura, S., Sharma, K., & Giannakos, M. (2022). Children’s play and problem-solving in Motion-based Learning Technologies using a Multi-modal Mixed Methods Approach. International Journal of Child-Computer Interaction, 31. https://doi.org/10.1016/j.ijcci.2021.100355
12. Liang, M., Li, Y., Weber, T., & Hussmann, H. (2021, June 22). Tangible Interaction for Children s creative Learning: A Review. ACM International Conference Proceeding Series. https://doi.org/10.1145/3450741.3465262
13. Lim, W. W., Yeo, K. J., & Handayani, L. (2022). The Perception of Special Education Teacher in Teaching Students with Dyslexia. International Journal of Evaluation and Research in Education, 11(2), 979–985. https://doi.org/10.11591/ijere.v11i2.22476
14. Matthews, S., Nicholas, M., Paatsch, L., Kervin, L., & Wyeth, P. (2025). Social and curious: Lessons in Designing Digital Manipulatives for Young Children. International Journal of Child-Computer Interaction, 44. https://doi.org/10.1016/j.ijcci.2025.100725
15. Meng, X., Chen, N., Ishida, J., Watanabe, K., & Murakami, T. (2023). Crossmodal Correspondences between Visual Features and Tastes in Preschoolers: An Exploratory Study. Frontiers in Psychology, 14. https://doi.org/10.3389/fpsyg.2023.1226661
16. Ministry of Education Malaysia. (2018). Dokumen Standard Kurikulum dan Pentaksiran: Reka Bentuk dan Teknologi Tahun 4.
17. Ministry of Education Malaysia. (2025). Garis Panduan Pengoperasian Pusat Perkhidmatan Pendidikan Khas (3PK).
18. Nathan, M. J., & Walkington, C. (2017). Grounded and embodied Mathematical Cognition: Promoting Mathematical Insight and Proof using Action and Language. Cognitive Research: Principles and Implications, 2(1). https://doi.org/10.1186/s41235-016-0040-5
19. Nurul Anis Mohd, Y., Che Din, N., Ahmad, M., Ibrahim, N., Razak, R. A., & Harun, D. (2018). Interventions for Children with Dyslexia: A review on Current Intervention Methods. Med J Malaysia.
20. Obrist, M., Gatti, E., Maggioni, E., Vi, C. T., & Velasco, C. (2017). Multisensory Experiences in HCI. IEEE Multimedia, 24(2), 9–13. https://doi.org/10.1109/MMUL.2017.33
21. OECD. (2023). PISA 2022 Results (Volume I): The State of Learning and Equity in Education, PISA, OECD Publishing. OECD Publishing. https://doi.org/10.1787/53f23881-en

22. Parliament of Malaysia. (2023). Penyata rasmi Parlimen Dewan Negara: Mesyuarat Pertama, Penggal Kedua, Parlimen Kelima Belas.
23. Pouw, W. T. J. L., van Gog, T., & Paas, F. (2014). An Embedded and Embodied Cognition Review of Instructional Manipulatives. In Educational Psychology Review (Vol. 26, Number 1, pp. 51–72). Springer Science and Business Media, LLC. https://doi.org/10.1007/s10648-014-9255-5
24. Qi, W., Chen, C.-H., Niu, T., Lyu, S., & Sun, S. (2024). A Multisensory Interaction Framework for Human-Cyber–Physical System based on Graph Convolutional Networks. Advanced Engineering Informatics, 61, 102482. https://doi.org/https://doi.org/10.1016/j.aei.2024.102482
25. Spence, C. (2011). Crossmodal correspondences: A Tutorial Review. In Attention, Perception, and Psychophysics (Vol. 73, Number 4, pp. 971–995). https://doi.org/10.3758/s13414-010-0073-7
26. Xin, J., Syuhada Binti Mat Sin, N., Kong, V., & Soon, L. (2026). Augmented Reality Integrated Sensory Books for Contextual Vocabulary Learning in Deaf and Hard-of-Hearing (DHH) Children: A Systematic Literature Review (2021-2026). Journal of Art, Design and Creative Media, 1(1), 1–17. https://doi.org/10.37134/jadcm.vol1.1.1.2026
27. Yuege, S., & Zaharudin, R. (2025). Implementation of Universal Design Learning (UDL) towards Knowledge, Skills and Engagement among Inclusive Education Teachers in China's Inclusive Classroom. Asia Pacific Journal of Educators and Education, 40(1), 193–214. https://doi.org/10.21315/apjee2025.40.1.10