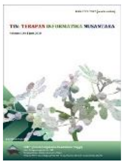

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User Experience Analysis of a Multimodal Digital Application Integrating Multiple Intelligences for Young Learner

Rini Juliana Sipahutar[1,*], Natalia Silalahi[2], Nina Afria Damayanti[1]

[1] Faculty of Education, Early Childhood Education, Universitas Negeri Medan, Medan, Indonesia
[2] Faculty of Education, Elementary Teacher Education, Universitas Negeri Medan, Medan, Indonesia
Email: [1,*]rinijuliana@unimed.ac.id, [2]natalia.novena.silalahi@gmail.com, [3]ninaafria@unimed.ac.id
Correspondence Author Email: rinijuliana@unimed.ac.id

Abstract−Despite the increasing adoption of multimodal educational applications for young learners, empirical research that explicitly examines young learner's user experience from the perspective of cognitive diversity remains limited. Many existing studies emphasize learning outcomes or technical usability, while insufficient attention is given to affective engagement, interaction behavior, and experiential quality during young learner's interaction with multimodal systems. This gap highlights the need for a structured analysis of how multimodal interaction grounded in the Multiple Intelligences (MI) framework shapes young learner's user experience. This study examines young learner's user experience while interacting with an existing multimodal educational application that incorporates the MI framework as a foundation for its interaction structure. The research explores how visual, auditory, and kinesthetic elements influence children's engagement, affective responses, and interaction behaviors. A qualitative descriptive design was employed through systematic observation and semi-structured interviews involving five young learners aged 5–6 years (N = 5), along with accompanying educators. The study introduces an adapted user experience analysis framework tailored for young learner's multimodal interaction contexts. Thematic analysis was conducted to identify interaction patterns and usability factors shaping the overall experience. The findings indicate that multimodal interaction enhances engagement, motivation, and accessibility, particularly for children with diverse intelligence profiles. Integrating Multiple Intelligences principles supports adaptive interaction pathways that improve satisfaction and sustained attention. This study contributes to the field of Human Computer Interaction (HCI) by providing empirical evidence on how cognitive diversity can inform the evaluation and design of multimodal interfaces for young learners.

Keywords: User Experience; Multimodal Interaction; Multiple Intelligences; Young Learners; Educational Application

1. INTRODUCTION

The rapid development of digital technology has significantly reshaped the ways in which children engage with learning, communication, and creative exploration. In the contemporary educational landscape, digital applications are no longer conceived as passive instructional media but as dynamic multimodal environments that integrate perception, cognition, and emotion. These environments allow children to experience learning through multiple sensory channels, combining visual, auditory, and kinesthetic engagement into a single interactive process. This shift represents a broader transformation in educational epistemology in which learning is conceptualized as an embodied and affective process rather than a linear transmission of information (Suárez et al., 2024). Through multimodal design, knowledge is co-constructed by children as they manipulate, observe, and respond emotionally to digital stimuli that activate both cognitive and sensory pathways (Luo, 2023)(Lu & Hu, 2025).

Within the discipline of Human Computer Interaction, this transformation has inspired the emergence of a distinct research area known as Child Computer Interaction, which focuses on the distinctive ways children experience, interpret, and respond to digital systems (Hourcade, 2022). Research in this area demonstrates that user experience in children cannot be understood merely as the efficiency or effectiveness of task performance. Instead, it encompasses affective, motivational, and aesthetic aspects that determine the quality of engagement (Lalmas et al., 2014; Marques et al., 2021). Children approach technology through play, imagination, and exploration, and these experiential modes require evaluation frameworks that can account for emotional involvement, sustained attention, and curiosity as integral components of usability.

Multimodal interaction, which engages multiple sensory channels simultaneously, lies at the core of this experiential process. Previous studies have shown that when visual, auditory, and kinesthetic elements are combined, children's comprehension, memory, and motivation are enhanced because information is encoded through multiple representational systems (K. Liu & Dr. Erna A. Lahoz, 2024). The theory of embodied cognition explains this phenomenon by emphasizing that cognitive activity emerges through sensory and motor engagement. Thinking and learning therefore occur through bodily experience and perceptual interaction rather than abstract reasoning alone (Dernikos et al., 2020). In this context, multimodal interaction serves as a mechanism that connects perception, movement, and affect into a coherent experience of learning.

Several previous studies have empirically supported the relevance of multimodal interaction and experiential user experience in children's digital learning environments. Studies by (Luo, 2023),(Lu & Hu, 2025) and (K. Liu & Dr. Erna A. Lahoz, 2024) demonstrate that the integration of visual, auditory, and kinesthetic modalities improves children's comprehension, memory retention, and learning motivation. These findings are consistent with embodied cognition research, which emphasizes that cognitive processes are grounded in sensory and motor experiences (Dernikos et al., 2020).

From the perspective of Child–Computer Interaction, (Hourcade, 2022) and (Lalmas et al., 2014; Marques et al., 2021) highlight that children's interaction quality is strongly influenced by affective and experiential factors such as

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enjoyment, curiosity, and emotional engagement, rather than task efficiency alone. Furthermore, O'Brien et al. (2018) propose multidimensional user experience constructs focused attention, involvement, novelty, aesthetics, and endurability that have been widely adopted to explain sustained engagement in interactive systems.

In parallel, research grounded in Multiple Intelligences theory shows that multimodal digital designs can activate diverse cognitive domains, including spatial, musical, linguistic, and bodily kinesthetic intelligences, thereby supporting inclusive and personalized learning experiences (Leong, 2025; Mukuni et al., 2023). These studies collectively provide a theoretical and empirical basis for examining children's user experience in multimodal digital applications.

Despite the recognized potential of multimodal design, empirical research that explicitly focuses on children's user experience remains limited. Many studies in educational technology continue to prioritize learning outcomes or technical usability, while affective, behavioral, and motivational dimensions that shape the overall quality of children's interaction are often underexplored. Although the ISO 9241-210 standard defines user experience as a holistic construct encompassing emotional, cognitive, and behavioral responses, few studies operationalize this definition within child-centered digital contexts.. However, few studies operationalize this multidimensional definition for children's digital contexts. Quantitative measures such as task accuracy or time spent on interaction provide only partial understanding when detached from qualitative indicators such as observable engagement, facial expressions, or verbalized enthusiasm (Buono et al., 2023; Hu & Gao, 2024).

To address these complexities, user experience in child centered systems can be analyzed through six interrelated dimensions that capture both cognitive and affective elements. These dimensions include focused attention, perceived usability, aesthetics, novelty, involvement, and endurability. Focused attention represents the ability of children to concentrate and maintain engagement throughout interaction. Perceived usability refers to the perceived ease, clarity, and comfort of use. Aesthetics describes the visual and sensory appeal of the application, while novelty captures the degree of curiosity and excitement evoked by new experiences. Involvement denotes emotional immersion and a sense of personal connection during interaction, whereas endurability reflects the lasting positive impression or memory that persists after the activity. Together, these dimensions illustrate the holistic character of user experience as a combination of attention, satisfaction, and emotional resonance.

Parallel to the construct of user experience, the theoretical framework of Multiple Intelligences proposed by Gardner (1983) provides a meaningful foundation for understanding how cognitive diversity influences children's interaction with digital media. Gardner's model identifies eight domains of intelligence: linguistic, logical mathematical, musical, bodily kinesthetic, spatial, interpersonal, intrapersonal, and naturalistic. Each representing a distinct cognitive capacity that can be activated through specific sensory modalities. When applied to digital design, this framework encourages the creation of inclusive learning environments that respect differences in perception and reasoning (Leong, 2025; Mukuni et al., 2023). Visual components of a digital application tend to stimulate spatial reasoning, rhythmic and melodic sound design activates musical intelligence, gesture based interaction supports bodily kinesthetic reasoning, and verbal instructions foster linguistic processing. In this way, the alignment of multimodal design with Multiple Intelligences theory enables digital applications to become adaptive systems that simultaneously support different forms of learning engagement.

The conceptual relationship between user experience dimensions and Multiple Intelligences domains positions the multimodal digital application as a mediating framework that connects sensory, emotional, and cognitive processes. The dimensions of user experience explain how children feel and respond during interaction, while the domains of Multiple Intelligences identify the cognitive pathways that are activated by these experiences. Focused attention and involvement are closely related to intrapersonal and kinesthetic development, aesthetics and novelty are associated with spatial and musical sensitivities, and perceived usability and endurability reflect how cognitive clarity and emotional satisfaction influence learning persistence. By interpreting multimodal interaction through this dual lens, it becomes possible to link affective and behavioral manifestations of experience with underlying cognitive mechanisms.

However, despite the conceptual compatibility between these perspectives, there remains a scarcity of empirical research that explicitly examines the correspondence between user experience and intelligence domains. Educational applications frequently claim to apply Multiple Intelligences principles, yet structured evaluations rarely demonstrate how specific multimodal features relate to distinct forms of intelligence or measurable behavioral outcomes (Giannakos & Cukurova, 2023; Lee & Aspiranti, 2023). Similarly, user experience assessments often adopt adult oriented frameworks that fail to capture the developmental and emotional nuances of children's interaction. These gaps highlight the need for integrated research models that can connect measurable UX indicators, such as attention, involvement, and satisfaction ,with theoretical constructs of cognitive diversity.

Recent developments in applied informatics and affective computing offer promising approaches to addressing these methodological challenges. By combining behavioral observation, affective analysis, and cognitive mapping, researchers can identify how multimodal stimuli evoke different emotional and cognitive responses (Gao et al., 2023; He et al., 2020). This multidimensional approach allows the study of user experience as both an observable behavior and a subjective process shaped by sensory engagement. When linked with the framework of Multiple Intelligences, such analysis can reveal how each sensory modality supports particular cognitive domains and how these domains contribute to sustained motivation, satisfaction, and engagement.

Based on these theoretical and empirical considerations, the present study investigates the user experience of children interacting with a multimodal digital application that integrates the principles of Multiple Intelligences. The study pursues two interrelated objectives. The first objective is to identify measurable dimensions of user experience:

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focused attention, perceived usability, aesthetics, novelty, involvement, and endurability, that emerge during multimodal interaction. The second objective is to examine the correspondence between specific multimodal features and distinct domains of intelligence, including linguistic, logical mathematical, musical, bodily kinesthetic, spatial, interpersonal, intrapersonal, and naturalistic. By integrating user experience evaluation with cognitive design theory, this research contributes to the broader field of human computer interaction and applied educational informatics by demonstrating how multimodal digital environments can be designed to foster meaningful, adaptive, and inclusive learning experiences for children.

2. RESEARCH METHODOLOGY

2.1 Basic Research Framework

This study employed a qualitative case study design that integrates the principles of Human Computer Interaction (HCI) and User Experience (UX) evaluation within the framework of Multiple Intelligences (MI) theory. The purpose of this research was to analyze the user experience of children as they interacted with an existing multimodal educational game designed to support children's learning through interactive tasks that incorporates visual, auditory, and kinesthetic modalities to stimulate diverse intelligence domains.

The study was conducted in Medan, Indonesia, from March to November 2025, involving five children aged 5–6 years selected through purposive sampling based on their familiarity with touch-screen devices and ability to follow guided interaction tasks. The research environment was designed as a play-based setting to encourage authentic and natural behavioral responses.

The study focused on exploring the relationships between multimodal interaction features (visual, auditory, and kinesthetic) and user experience dimensions, namely focused attention, perceived usability, aesthetics, novelty, involvement, and endurability adapted from O'Brien et al. (2018). It also examined how these multimodal features correspond to eight domains of Multiple Intelligences (linguistic, logical-mathematical, musical, bodily-kinesthetic, spatial, interpersonal, intrapersonal, and naturalistic) (Gardner, 1983).

Data were collected through participatory observation, semi-structured interviews, and interaction content analysis, supported by video documentation. Triangulation of data sources and methods was applied to enhance validity and reliability. The conceptual structure of this study is presented in Figure 1, illustrating the relationship among multimodal features, user experience dimensions, and multiple intelligences domains.

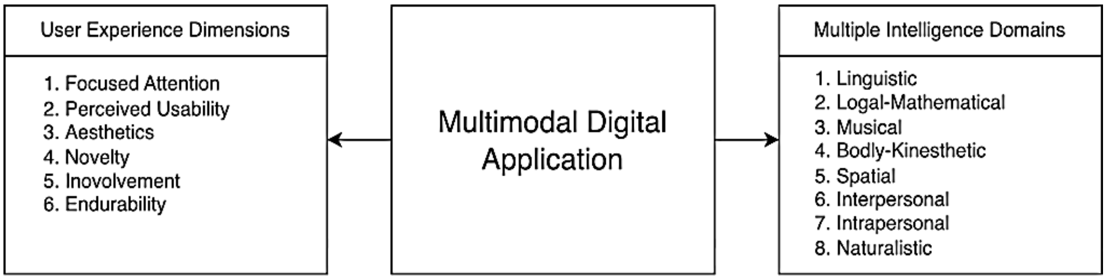

Figure 1. Basic Research Framework

Figure 1 presents the conceptual framework of this study, in which the multimodal digital application is positioned as an intermediary between user experience dimensions and Multiple Intelligence domains. The user experience dimensions, namely focused attention, perceived usability, aesthetics, novelty, involvement, and endurability, represent the affective, cognitive, and behavioral responses of children during interaction. These dimensions describe how children perceive, engage with, and emotionally respond to the digital application. The multimodal digital application serves as the central mechanism that integrates visual, auditory, and kinesthetic modalities, enabling interaction through multiple sensory channels. Through this process, multimodal stimuli activate various intelligence domains shown on the right side of the framework, including linguistic, logical mathematical, musical, bodily kinesthetic, spatial, interpersonal, intrapersonal, and naturalistic intelligences. The relationships illustrated in the framework indicate that user experience dimensions influence the effectiveness with which intelligence domains are activated, while the activation of specific intelligence domains contributes to children's engagement, attention, and lasting impressions. This framework provides an analytical explanation of how affective user experience and cognitive diversity are connected through multimodal interaction and forms the basis for examining the correspondence between observable user experience indicators and Multiple Intelligence domains in this study.

2.2 Research Stages

The research followed a systematic process divided into six stages, as shown in Figure 2. This structured approach ensured transparency and replicability in the qualitative research process.

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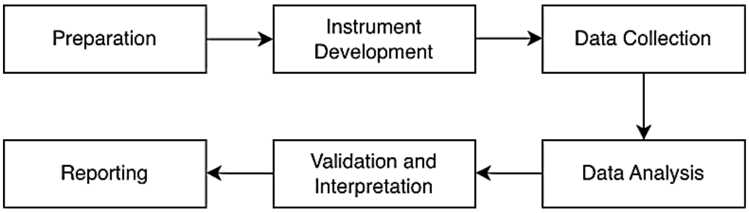

Figure 2. Research Stages

Figure 2 illustrates the sequential methodological framework employed in this study, outlining the main stages of the research process from preparation to reporting. The diagram provides an overview of how the study was systematically conducted, beginning with the preparation phase, followed by instrument development and data collection, and continuing through data analysis, validation and interpretation, and final reporting. This visual representation serves to clarify the logical flow and interconnection between research stages, while the detailed description of activities conducted at each stage is presented in the subsequent subsections.

a. Preparation: This stage involved conducting a comprehensive literature review on multimodal interaction, user experience for children, and the application of Multiple Intelligences (MI) theory in digital learning environments. Research objectives and frameworks were formulated, and ethical approval was obtained from the institutional committee. Parental consent was secured prior to each observation session to ensure compliance with ethical standards for research involving children.
b. Instrument development: The instrument development process aimed to construct valid and reliable tools to evaluate both behavioral and experiential aspects of children's interaction with the multimodal digital application. Three main instruments were designed. The first was an observation sheet that recorded behavioral indicators of engagement and usability observed during real-time sessions. The second was a user experience evaluation rubric adapted from O'Brien et al.'s (2018) User Engagement Framework, encompassing six dimensions of engagement: focused attention, perceived usability, aesthetics, novelty, involvement, and endurability. These dimensions capture the balance between cognitive investment, emotional appeal, and sustained interaction quality. The third instrument was a Multiple Intelligences (MI) mapping checklist based on Gardner's (1983) theory, which linked multimodal features (visual, auditory, and kinesthetic) with specific intelligence domains such as linguistic, musical, spatial, and kinesthetic intelligence. All instruments underwent expert validation by specialists in Human Computer Interaction (HCI) and Early Childhood Education (ECE). The validation procedure focused on item clarity, construct alignment, and ecological validity within play-based learning environments. Feedback from experts led to refinement of behavioral indicators and adaptation of rating scales to ensure they were developmentally appropriate for early childhood participants.
c. Data collection: Observations were conducted in a play-based classroom environment. Each child individually interacted with the application for approximately 20 minutes using a tablet device. Behavioral expressions, gestures, and verbal reactions were recorded through video documentation. Semi-structured interviews with parents provided complementary insights into children's motivation, comprehension, and affective responses. Semi-structured interviews with parents provided complementary insights into children's motivation, comprehension, and affective responses. Interviews with parents or accompanying educators were prioritized over direct interviews with children aged five to six years because children at this developmental stage have limited verbal articulation, reflective ability, and attention span, which may reduce the reliability of self-reported data. Parents and educators, as consistent observers of children's behavior, are better positioned to provide accurate and ethically appropriate interpretations of children's responses across learning and play contexts.
d. Data analysis: All qualitative data were analyzed using thematic analysis (Braun & Clarke, 2006). The process included transcription, reduction, coding, categorization, and theme generation. Each coded segment was first classified according to multimodal features: visual, auditory, or kinesthetic and then examined based on six UX dimensions: focused attention, perceived usability, aesthetics, novelty, involvement, and endurability. The resulting UX patterns were subsequently mapped to corresponding domains of Multiple Intelligences (Gardner, 1983) to identify cognitive tendencies such as linguistic, musical, spatial, or kinesthetic engagement. This two-level analysis revealed how multimodal interaction features influenced both experiential and cognitive responses. Triangulation across observation, interview, and documentation ensured credibility and dependability of the findings.
e. Validation and interpretation: Credibility was established through triangulation, peer debriefing**,** and expert consultation to verify conceptual accuracy and interpretive validity. The peer involved in the peer debriefing process was a fellow researcher with expertise in Human Computer Interaction and educational technology, who was not directly involved in data collection and analysis, and who provided an independent critical review of coding decisions and interpretive conclusions. The interpreted results were synthesized to identify interaction characteristics that enhanced both cognitive activation and affective engagement during children's use of the multimodal application.
f. Reporting: The final stage involved the compilation of findings, interpretation of implications for multimodal application design, and presented according to academic reporting conventions. Recommendations for educational technologists and interface designers were formulated to improve child-centered digital environments.

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3. RESULTS AND DISCUSSION

The analysis addressed two main research questions: (1) the aspects of user experience emerging from children's interaction with an existing multimodal educational application, and (2) the correspondence between specific multimodal features and different domains of multiple intelligences. Observation and interview data revealed that the children's experiences were multisensory, affective, and cognitively stimulating, reflecting how multimodal design mediates both usability and intelligence engagement.

3.1 User Experience Aspects

The application was specifically designed for early childhood learners and integrates multiple sensory modes to stimulate exploration, reasoning, and creativity. Its visual interface presents colorful animated objects, symbolic icons, and dynamic transitions that attract attention and encourage visual discrimination, reflecting the importance of perceptual salience in children's engagement (Caiola et al., 2023). The auditory layer provides spoken instructions, rhythmic sound effects, and melodic background cues that guide task completion and reinforce verbal comprehension, consistent with evidence that sound enhances memory and linguistic processing (Toader et al., 2023). The kinesthetic component enables direct interaction through dragging, dropping, rotating, and tapping gestures, enabling children to manipulate objects and observe cause–effect relationships through embodied action, which aligns with theories of embodied cognition emphasizing the integration of perception and movement in learning (Lee-Cultura et al., 2022). In addition, the system offers haptic feedback through mild vibrations, adaptive contextual progression based on performance, and social–affective elements such as character dialogue and emotional feedback, which contribute to an emotionally supportive learning environment (H. L. Liu et al., 2022).

This combination emphasizes experiential play rather than instructional rigidity, allowing children to explore freely while remaining oriented toward meaningful goals. Such integration of sensory, cognitive, and affective features simulates authentic learning experiences and aligns with the view that multimodal interaction facilitates engagement through multisensory embodiment.

The thematic analysis identified six key user experience dimensions that emerged from children's interaction with the multimodal digital application: focused attention, perceived usability, aesthetics, novelty, involvement, and endurability. These dimensions collectively describe how the multimodal interface engaged children's sensory, cognitive, and emotional processes during play-based interaction. The summary of these dimensions and their observable behavioral indicators can be seen in Table 1.

Table 1. User Experience Dimensions and Behavioral Indicators

UX Dimension	Behavioral Indicators	Illustrative Example	Interpretation
Focused attention	Sustained gaze and concentration when observing moving visuals or sound cues (observed in 4 out of 5 children, 80%); minimal distraction during task execution.	Children consistently followed the motion of animated objects and synchronized their gestures with audio prompts.	Indicates cognitive engagement and attentional focus triggered by visual–auditory synchrony
Perceived Usability	Ability to navigate icons and perform drag-and-drop tasks without repeated errors (5 out of 5 children, 100%); quick adaptation after short instruction.	Most users adapted quickly to drag-and-drop tasks and corrected mistakes independently during	Reflects intuitive interaction design aligned with early-childhood motor and cognitive abilities.
Aesthetics	Expressed delight through smiles or verbal appreciation of colors, shapes, and animation (4 out of 5 children, 80%).	Children frequently smiled, vocalized approval, or pointed to attractive elements during gameplay.	Suggests that visual pleasure contributes to emotional comfort and motivation
Novelty	Showed curiosity and exploratory behavior toward new icons, sounds, or game levels (5 out of 5 children, 100%).	Children tapped unfamiliar icons, triggered hidden animations, and verbalized excitement when discovering new effects.	Indicates curiosity-driven learning through multimodal exploration
Involvement	Active participation through gestures, comments, and verbal reactions; consistent engagement without external prompting (4 out of 5 children, 80%).	Children frequently used self-directed speech, gestures, and repetition to maintain progress.	Demonstrates immersive flow state where challenge and skill are balanced
Endurability	Desire to repeat the same task or level; extended playtime beyond the instruction phase (3 out of 5 children, 60%).	Several children requested to replay the same level or explore alternative features after finishing.	Reflects emotional satisfaction and sustained interest beyond immediate rewards.

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The findings indicate that focused attention and involvement were primarily encouraged by the integration of visual and auditory cues, while aesthetics and novelty fostered emotional excitement and sustained curiosity. Perceived usability supported independent exploration, enabling children to understand cause–effect relationships through tactile feedback. Endurability, as reflected in their desire to replay, highlighted intrinsic enjoyment that persisted beyond task completion. One child, for instance, exclaimed, *"It's talking to me!"* upon hearing a feedback voice, showing delight and linguistic engagement. Another laughed when animations changed color after a correct action, illustrating affective resonance with visual feedback.

Overall, these six dimensions demonstrate that user experience in early childhood digital interaction extends beyond functional performance. It includes curiosity, enjoyment, persistence, and affective connection, supporting the view that effective learning emerges from the synthesis of usability and emotion. The results confirm that pleasurable interaction enhances perceived effectiveness and align with Csikszentmihalyi's concept of flow, which emphasizes that engagement arises naturally when challenge and skill are balanced (Csikszentmihalyi, 1990). This indicates that the multimodal application successfully created a playful yet cognitively meaningful learning environment where attention, motivation, and affect coexisted as integrated components of experience.

3.2 Mapping of Multimodal Features and Multiple Intelligences

The second research question explores how the multimodal features of an existing educational application correspond to specific domains of Multiple Intelligences (MI)**.** Contemporary research on multimodal interaction emphasizes that user experience is shaped not only by visual, auditory, and kinesthetic modalities but also by affective, contextual, and feedback-based cues that dynamically enhance both cognition and emotion (Dritsas et al., 2025). According to this view, multimodal systems integrate speech, gesture, touch, haptics, and environmental context in a synchronized and adaptive manner, allowing users to process information across multiple sensory and affective channels.

Within this framework, the current study identifies six core modalities embedded in the multimodal digital application: visual, auditory, kinesthetic, haptic feedback, contextual adaptation**,** and social affective interaction each contributing distinctively to the activation of cognitive and emotional domains in children. The mapping results are summarized in Table 2.

Table 2. Correspondence between Multimodal Features and Multiple Intelligence Domains

Multimodal Feature	Representative Digital Element	Stimulated Multiple Intelligences	Mechanism of Stimulation	Empirical Observation
Visual	Colors, shapes, animated movement	Visual Spatial, Naturalistic	Enhances visual differentiation, environmental awareness, and spatial reasoning through dynamic imagery.	Children identified shapes and colors, e.g., "triangle as the roof," linking digital visuals with real-world forms.
Auditory	Instructional voice, background melody, and praise feedback	Musical, Linguistic	Strengthens rhythmic perception, auditory memory, and language acquisition through repetition and tone variation.	Children repeated verbal instructions rhythmically, showing improved speech imitation and recall.
Kinesthetic	Touch gestures such as drag, drop, and rotation	Bodily-Kinesthetic, Logical-Mathematical	Develops motor coordination and logical sequencing through tactile exploration and manipulation.	Children refined object placement through repeated trial and error, reflecting embodied learning.
Haptic Feedback	Vibrations, tactile response upon success	Intrapersonal	Reinforces emotional awareness and satisfaction through tangible reinforcement.	Children expressed pride and joy when devices vibrated or gave tactile feedback after correct actions.
Contextual Adaptation	Level progression and difficulty adjustment	Logical–Mathematical, Intrapersonal	Promotes problem-solving and self-regulation by adapting task complexity based on performance.	Children maintained motivation as the app adjusted task speed or pattern complexity.
Social–Affective Interaction	Character dialogue, cooperative gameplay elements	Interpersonal, Intrapersonal	Encourages empathy, collaboration, and self-reflection through shared play and narrative context.	Children interacted verbally, showing emotional engagement with the character's goals.

The mapping presented above demonstrates that multimodal interaction can simultaneously activate multiple intelligence domains through interlinked sensory and affective experiences. The visual and auditory modalities

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primarily supported the development of spatial, musical, and linguistic intelligences by engaging perception and rhythmic pattern recognition, while the kinesthetic and haptic components nurtured bodily coordination and emotional awareness, reaffirming the embodied nature of children's cognition. Contextual adaptation provided cognitive scaffolding that encouraged persistence and self-regulation, corresponding to logical–mathematical and intrapersonal intelligences (Gardner, 1983).

The inclusion of social–affective interaction in the application further reinforced interpersonal engagement, demonstrating that emotional reciprocity and cooperative play are central to the learning experience. Children's verbal responses to characters and narrative prompts indicated that empathy and shared meaning-making were actively constructed through interaction. These findings resonate with the affective computing perspective, which posits that emotional feedback loops between user and system enhance motivation and engagement (Pervez et al., 2024).

Overall, the mapping results provide empirical evidence for the conceptual alignment between multimodal interaction and the Multiple Intelligences framework. The findings support the view that digital interaction can operationalize Gardner's domains through sensory diversity, affective feedback, and adaptive contextualization. Moreover, the data indicate that multimodal systems facilitate simultaneous rather than sequential activation of intelligence domains, leading to a richer and more inclusive learning experience (Guerrero-Sosa et al., 2025).

In summary, the multimodal educational application fostered an integrative learning context that balanced cognitive challenge with emotional support. The combination of perceptual richness, embodied interaction, and adaptive feedback produced an experience that engaged both the mind and senses, reinforcing the understanding of user experience as an emergent phenomenon shaped by the interplay of cognitive, affective, and environmental factors.

3.3 Relationship between User Experience and Multiple Intelligences Dimensions

The integration of user experience dimensions with Multiple Intelligences (MI) reveals a reciprocal relationship between sensory engagement, cognitive activation, and emotional satisfaction. The multimodal elements: visual, auditory, kinesthetic, haptic, contextual, and social–affective, collectively supported the emergence of six user experience dimensions: focused attention, perceived usability, aesthetics, novelty, involvement, and endurability. These dimensions represent a holistic interaction process in which perceptual, cognitive, and affective systems operate in concert to produce meaningful engagement and sustained learning.

Focused attention and perceived usability were closely associated with logical–mathematical and visual–spatial intelligences, suggesting that intuitive and structured interaction design facilitates early problem-solving and spatial reasoning. This finding supports Piaget's (1964) view that perceptual exploration contributes to the development of operational logic and abstract reasoning in early childhood. Aesthetics and novelty were linked to musical and naturalistic intelligences, as the combination of rhythm, color, and environmental symbolism triggered curiosity, emotional arousal, and creative exploration (Gardner, 1983). Meanwhile, involvement and endurability corresponded to interpersonal and intrapersonal intelligences, as continuous engagement was strengthened by emotional resonance, self-expression, and intrinsic motivation.

These cross-domain relationships demonstrate that user experience functions as a mediating layer connecting multimodal stimuli with cognitive and emotional outcomes. Consistent with Dritsas et al. (2025), multimodal interaction operates as an adaptive system that synchronizes sensory input, emotional feedback, and contextual factors to sustain engagement and cognitive flow. This mechanism aligns with the concept of the affective loop introduced by McDuff and Czerwinski (2018), where emotional feedback continuously informs user system interaction to preserve motivation and attention. The findings also extend Gardner's framework by suggesting that digital multimodality enables the simultaneous activation of multiple intelligence domains rather than isolated or sequential engagement. Such integration supports the growing perspective that inclusive learning design should utilize multisensory and affective affordances to accommodate both cognitive diversity and emotional variation among children.

Furthermore, the findings indicate a bidirectional relationship between user experience and cognitive activation. Cognitive engagement, stimulated by visual and kinesthetic interaction, appeared to reinforce emotional satisfaction and persistence, whereas positive affective feedback enhanced focus, self-regulation, and problem-solving behavior. This reciprocal reinforcement between emotion and cognition illustrates how user experience evolves dynamically as children adapt their interaction strategies based on affective cues and sensory feedback. The multimodal application thus served not merely as a learning environment but as an affective mediator shaping how children sustain attention, regulate emotions, and experience achievement during interaction.

From a design perspective, these results emphasize that effective child-centered digital applications should balance usability with emotional engagement. Meaningful multimodal experiences combine functional clarity, aesthetic pleasure, social interaction, and adaptive feedback. The synthesis of User Experience principles and Multiple Intelligences theory thus offers a coherent framework for creating digital learning environments that are intuitive, emotionally engaging, and cognitively inclusive. By integrating insights from affective computing and educational psychology, this study contributes to a broader understanding of how multimodal interaction fosters deep, enjoyable, and developmentally appropriate learning experiences for children.

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4. CONCLUSSION

This study analyzed children's user experience while interacting with an existing multimodal educational application**,** integrating the principles of Multiple Intelligences (MI) within a Human Computer Interaction (HCI) framework. The findings reveal that children's user experience encompasses not only functional usability but also affective and cognitive dimensions, represented by six interrelated aspects: focused attention, perceived usability, aesthetics, novelty, involvement, and endurability**.** Each of these aspects was shaped by multimodal features: visual, auditory, kinesthetic, haptic, contextual, and social–affective which collectively stimulated different domains of intelligence, including linguistic, logical–mathematical, spatial, musical, bodily–kinesthetic, interpersonal, intrapersonal, and naturalistic. The results demonstrate that multimodal interaction fosters the simultaneous activation of cognitive and emotional processes, supporting sustained engagement and self-motivation in children's digital learning experiences. However, this research was limited by the small number of participants and the restricted interaction contexts, which may limit the transferability of findings. Future studies should expand participant diversity, combine qualitative and quantitative validation, and explore adaptive multimodal systems capable of real-time affective feedback analysis. Overall, the integration of user experience analysis and Multiple Intelligences theory provides a valuable foundation for designing digital applications that are not only usable, but also emotionally engaging and cognitively inclusive. These insights contribute to the advancement of child-centered interactive technologies, emphasizing the importance of balancing usability, affect, and cognitive diversity in future educational innovations.

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