



Child-Centered User Interface Design for Early Language Learning Applications: A Qualitative Comparative Study

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ABSTRACT

Background: In the digital learning era, user interface (UI) design plays an important role in shaping how children engage with educational applications, particularly in early language learning contexts. However, many applications are not fully aligned with children's cognitive, emotional, and developmental needs.

Objective: This study aims to examine how UI design in child-centered language learning applications can be optimized to support children's cognitive and emotional needs while enhancing learning outcomes.

Method: This study adopts a qualitative comparative approach, integrating a literature review, visual analysis of two English-language learning applications (Duolingo ABC and BOOKR Class), semi-structured interviews with three design experts, and focus group discussions with six children aged 5–8. Data were collected through observation, expert validation, and user interaction, and analyzed using thematic analysis.

Results: The findings indicate that intuitive, minimal-step navigation reduces cognitive load and supports task completion; balanced color strategies sustain attention without overstimulation; large sans-serif typography improves reading accuracy; and expressive mascots enhance emotional engagement. However, children's preferences vary across developmental stages, highlighting the need for adaptive rather than standardized design approaches.

Conclusion: UI design functions as a pedagogical mediator that influences comprehension, engagement, and early literacy development. The study proposes a child-centered guideline integrating cognitive simplicity, emotional resonance, and context-sensitive design decisions, contributing to educational technology by demonstrating how developmentally aligned interface design can improve both usability and learning effectiveness.

Keywords: Child-Centered Learning; Early Language Learning; Educational Technology; Learning Outcomes; User Interface Design.

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INTRODUCTION

In the digital learning era, children are increasingly exposed to applications that function not only as entertainment but also as tools for education and cognitive development (Abdullah, 2025). Technology, particularly as an interactive learning medium at the elementary school level, has been shown to enhance the learning process by making it more engaging, interactive, and easier for students to understand. (Rinaldi et al., 2024). This shift became more prominent following the COVID-19 pandemic, when virtual learning evolved from an emergency solution into a sustained educational practice. Teachers and parents continue to play a crucial role in shaping children's digital literacy through guided engagement with online platforms and learning applications (Ningsih et al., 2021).

The growing integration of digital applications into early education reflects a broader transformation toward interactive and multimedia-based learning environments. However, the effectiveness of these applications is not determined solely by content, but also by how content is presented through the user interface (UI), which serves as the primary medium of interaction between children and learning materials. Many educational applications are still designed from an adult-centered perspective, overlooking the cognitive, perceptual, and emotional differences between children and adults. Prior studies indicate that abstract or symbolic interface elements can be difficult for children to interpret (Giannakoulas & Xinogalos, 2024; Wang et al., 2023), while complex navigation structures and feature-heavy interfaces may overwhelm young users (Mahmud et al., 2020; Yustin et al., 2016).

Children's cognitive processing and comprehension abilities differ significantly from those of adults, directly influencing how they engage with digital learning environments. This issue is further complicated by the presence of manipulative or misleading interface patterns, which children often fail to recognize due to limited critical awareness (Schäfer et al., 2024). Unlike adults, who can develop strategies to filter digital distractions, children struggle to distinguish between educational content and embedded advertisements or attention-grabbing elements (Feijóo & Pavez, 2019). Excessive interactivity, visual clutter, or rapid animations can also contribute to cognitive overload and reduce comprehension (Taylor et al., 2022). In some cases, poorly designed interfaces may even lead to reduced attention span or unhealthy patterns of digital engagement (Ntalindwa et al., 2022).

These challenges highlight that UI design is not merely a matter of usability or aesthetics but has direct implications for learning outcomes. From an educational perspective, inappropriate interface design can hinder comprehension, reduce motivation, and limit knowledge retention, thereby weakening the pedagogical effectiveness of digital learning tools (Huntington et al., 2023; Aziz & Fauziah, 2020). As digital applications increasingly function as extensions of formal education, their design must support not only engagement but also meaningful learning processes (Kim et al., 2021). Therefore, understanding how UI design influences children's learning experiences becomes essential for developing effective educational technologies (Sun, et al., 2019).

Among various educational applications, language learning and early literacy platforms are particularly significant, as they integrate visual, auditory, and interactive elements to support foundational skills such as phonemic awareness, vocabulary development, and sentence formation (Finders et al., 2023). Applications such as Duolingo ABC and BOOKR Class represent different pedagogical approaches, including gamified learning and narrative-based literacy, making them relevant contexts for examining the role of UI design in supporting children's engagement and comprehension. These applications rely heavily on interface

elements such as navigation cues, color-coded feedback, typography, and mascots to guide user interaction. Studies show that features such as large, touch-friendly buttons, clear progress indicators, and timely prompts can significantly influence children's reading accuracy, persistence, and emotional engagement during learning activities (Wibawanto & Nugrahani, 2018; Taylor et al., 2022).

Despite the rapid growth of digital learning technologies, there remains a lack of empirical research that specifically examines children's interaction patterns and preferences in relation to UI design. Many studies treat children as a homogeneous user group, without accounting for variations in developmental stages, including differences in attention span, motor skills, and symbolic understanding (Azeta, 2024). As a result, many applications labeled as "child-friendly" merely adapt adult-oriented design principles by enlarging interface elements or increasing color saturation, without addressing deeper aspects such as cognitive ergonomics, perceptual clarity, and emotional resonance (Zhang, 2025). This gap indicates a need for more context-sensitive and developmentally informed approaches to UI design in educational applications.

This study addresses this gap by identifying children's preferences in user interface design and examining how these preferences relate to learning effectiveness. This investigation is essential because educational applications for children must simultaneously fulfill educational value, aesthetic appeal, and technical functionality to ensure both meaningful learning outcomes and engaging user experiences (Kartini et al., 2020). Building on this premise, the study aims to develop a conceptual framework for child-centered interface design in early language learning applications by integrating findings from literature, application analysis, experts perspectives, and user validation. It focuses on four key UI components—navigation, color, typography, and icons or illustrations—to examine their influence on engagement, comprehension, and emotional comfort. The novelty of this study lies in its interdisciplinary integration of educational technology and visual communication design, positioning user interface design as a pedagogical mediator that supports cognitive processing, emotional engagement, and early literacy development. Accordingly, the study investigates how interface design can be optimized to align with children's cognitive, emotional, and aesthetic characteristics while maintaining educational effectiveness. It identifies children's design preferences, analyzes theory–practice alignment, and formulates a framework to support meaningful learning experiences and improved learning outcomes..

METHODS

Study Design and Participants

This study adopts a qualitative research method with a comparative approach to examine how user interface (UI) design in child-centered language learning applications can be optimized to align with children's cognitive, emotional, and aesthetic preferences while maintaining educational effectiveness. The comparative approach enables the identification of patterns and contrasts between theoretical principles and their practical implementation in existing applications (Doering & Cooper, 2022).

The study was conducted between August and October 2025 in Surabaya, Indonesia, with data analysis and manuscript preparation continuing until submission in March 2026. The overall research workflow is illustrated in Figure 1.

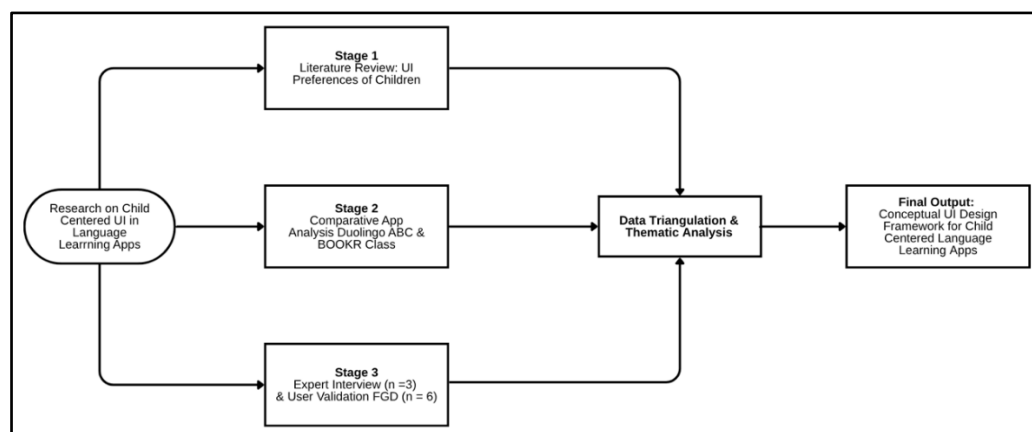


Figure 1 Research Workflow Diagram

The research focuses on two widely used child-centered language learning applications, Duolingo ABC and BOOKR Class, selected purposively based on their distinct pedagogical approaches to early literacy (Etikan et al., 2016). Both applications are rated above 4.2 on Google Play and the Apple App Store, are designed for users aged 4+, and align with early literacy objectives. Duolingo ABC emphasizes gamified learning, while BOOKR Class focuses on narrative-based comprehension (Lamrani & Abdelwahed, 2020).

The study involved three ($n = 3$) UI/UX design experts serving as Design Learning Facilitators at the Apple Developer Academy, each with more than five years of experience in designing digital learning applications. Additionally, a focus group discussion (FGD) was conducted with six children ($n = 6$) aged 5–8 years, accompanied by their parents. The sampling approach was purposive, targeting participants relevant to early language learning contexts. The sample size was considered appropriate for qualitative inquiry, as thematic insights in focused studies can be achieved with a limited number of participants or sessions (Hennink & Kaiser, 2022).

The FGD session was structured as a play-based interaction in a controlled and quiet environment (Sjamsir et al., 2024). The protocol included a warm-up phase, guided exploration of both applications using a tablet, think-aloud prompts, and short preference-based questions. To minimize bias, the order of application exposure was counterbalanced, and facilitators avoided evaluative or leading language (Hanghøj et al., 2020). Data collection relied on non-identifiable field notes documenting navigation behavior, mis-taps, hesitation points, and spontaneous verbal responses related to UI elements.

Ethical approval statement

This study was conducted in accordance with institutional research approval (No. UC-RES26040055). Parental consent and child assent were obtained prior to participation, and all data were collected in a non-identifiable manner in line with ethical research practices (Askari et al., 2024).

Research Instruments

Data collection was carried out through three interconnected stages, as illustrated in Figure 1. The first stage involved a literature review of studies published between 2015 and 2025 on child-centered UI design and educational technology. Sources were selected from Scopus and Google Scholar based on relevance and credibility.

The second stage consisted of a visual and interaction analysis of the selected applications, conducted over approximately two weeks using both mobile and tablet devices. The primary instrument used was an observation checklist developed based on established constructs in child–computer interaction and educational media

studies, ensuring content validity through theoretical grounding, and piloted on two unrelated applications to refine clarity and reduce redundancy (Roseli & Aziz, 2023; Diehl et al., 2022; Feng, 2022; Zhao et al., 2022; Sari et al., 2024).

The checklist covered four key elements: navigation, color, typography, and icons or illustrations. Navigation was evaluated based on intuitiveness and cognitive load (Sari et al., 2024), color based on emotional and perceptual effects (Roseli & Aziz, 2023; Diehl et al., 2022), typography based on readability and visual hierarchy (Diehl et al., 2022), and icons or illustrations based on recognizability and symbolic clarity (Feng, 2022; Zhao et al., 2022; Roseli & Aziz, 2023).

The third stage involved semi-structured expert interviews aimed at validating findings and exploring pedagogical and practical considerations in UI design.

Data Analysis

All data were analyzed using thematic analysis following six-phase framework, including data familiarization, initial coding, theme generation, review, definition, and reporting (Braun and Clarke, 2006). Coding was conducted manually to identify recurring themes related to the four UI components and their impact on children's engagement, comprehension, and emotional responses.

To ensure validity and reliability, triangulation was applied across multiple data sources, including literature review, application analysis, expert interviews, and FGD findings. Cross-verification between theoretical insights and empirical observations strengthened the credibility and trustworthiness of the results.

RESULTS

Comparative findings from the literature review, app observations, expert interviews, and focus group discussions (FGD) reveal convergent insights across four key user interface (UI) components: navigation, color, typography, and icons or illustrations. These components illustrate how children cognitively interpret interface elements and respond to interaction cues in digital learning environments (Endarini & Chaniago, 2025), directly addressing the research question.

To provide a clearer synthesis of these findings, Table 1 presents a comparison of theoretical expectations, observed practices in Duolingo ABC and BOOKR Class, expert perspectives, and user validation results. This comparison demonstrates how child-centered design principles are implemented and perceived differently depending on pedagogical goals, target age groups, and interaction models.

The triangulated findings indicate that both applications align with child-centered design principles but apply them differently based on pedagogical focus and interaction style. Experts insights emphasize age segmentation and context-sensitive decisions across UI components (Bsdurrek & Meng, 2025), while FGD results show that children's responses vary by age, familiarity, and visual preference. Overall, effective child-centered UI design emerges not from fixed formulas but from adaptable principles that balance clarity, engagement, and emotional resonance, forming the foundation for the proposed conceptual framework (Yunus et al., 2015).

The following subsections examine each UI component in detail, synthesizing theoretical expectations, observed practices, experts perspectives, and user validation to derive component-specific design recommendations for child-centered language learning applications.

Table 1 Comparative Analysis of UI Components in Child-Centered Language Apps

UI Component	Theoretical Principle	Duolingo ABC (Observed)	BOOKR Class (Observed)	Expert Evaluation (Apple Developer Academy Facilitators)	User Validation (FGD with Children Aged 5–8)
Navigation	Simple, consistent navigation with fewer than three steps to main content (Gumulya & Suhanto, 2024); tab bars with labels and icons improve clarity; bottom menus suit mobile devices (Hassan, et al., 2023).	Single-page layout; 1–2 clicks to content; icon-only navigation; horizontal scrolling for levels.	Four-segment top tab bar; 1 click to content; combined icons and labels; vertical scrolling.	Design should adapt icons by age (simple vs. abstract with cues); top bars prevent accidental taps; provide visual hints for scrolling. Combine icons with labels for older children; use icon-only for pre-literate users.	Younger children (6–10) distracted by Duolingo's horizontal level map; older followed intended flow. In BOOKR, all ages focused on book thumbnails over menu. Older children recognized tab-bar icons; younger made errors. Labelled icons (BOOKR) aided clarity; illustrated ones (Duolingo) encouraged exploration.
Color	Bright, high-contrast colors enhance engagement (Maule, 2023; Gu, 2023)	Varied bright palette (blue, green, red, yellow, purple); cool tones for buttons and progress indicators.	Dominant cool colors (purple-blue, white); limited variation.	Both apps use appropriate palettes, but intensity should match context. Educational apps need less saturation than games. Prioritize color harmony and accessibility; oversaturation distracts from learning.	Children preferred Duolingo's bright palette. BOOKR thumbnail choices showed age-based pattern: younger chose bright fantasy covers; older preferred darker, muted covers aligned with interests (e.g., science, history). Suggests shift from color-driven to content-driven selection with age.
Typography	Sans-serif fonts enhance readability and recognition (Martens et al., 2018); Callaghan & Reich, 2020).	Sans-serif font with large size (>16 pt), high contrast, and regular letter shapes.	Sans-serif, large size (40 pt for desktop), high contrast, regular letterforms.	Both apps are readable. Sans-serif recommended for children; serif can enhance thematic narratives if used carefully. Maintain generous spacing, simple letterforms; avoid decorative scripts.	Testing limited: Duolingo's minimal text offered little to assess. In BOOKR, older children showed no reading speed difference between serif and sans-serif. Youngest hesitated slightly with serif. No child consciously noticed font differences.
Icons & Illustrations	Icons should depict familiar real-world objects. Mascots and parasocial characters enhance engagement and comprehension (Taylor, et al., 2022)	Uses mascots (Duo the Owl, Junior the Bear) to guide users and provide feedback; narrator gives audio instructions.	Animated story characters only; no persistent mascot, though a bunny appears in other BOOKR media.	Consistent mascots strengthen engagement but are not essential. If core content features strong characters, mascots serve branding more than guidance. Interactivity can use animated feedback, visual cues, or character-driven narratives instead.	Duolingo's mascots strongly engaged younger children ("cute," "fun"), increasing app-opening motivation though not always lesson completion. Older children found them merely entertaining. BOOKR maintained engagement without mascots through character-driven story content.

Navigation

Navigation is central to supporting children's intuitive exploration and comprehension. As noted by [Latiff et al. \(2019\)](#), simple and consistent navigation supports developing cognitive abilities and prevents overload in working memory. As seen in Figure 2, Duolingo ABC's single-page interface with visual level paths minimizes cognitive effort, while BOOKR Class organizes its content through a structured four-tab menu as seen in Figure 3. Both designs achieve simplicity through different strategies: direct visual progression versus systematic categorization.

Experts emphasized that navigation effectiveness depends not only on layout but also on age segmentation and contextual clarity. They highlighted that icon comprehension varies by icon complexity, and that horizontal scrolling is acceptable as long as clear visual hints are provided. This perspective complements existing recommendations that device type and user age should inform menu placement, confirming that bottom menus suit handheld screens, while top or left menus benefit larger displays ([Norouzi et al., 2021](#); [Xie et al., 2015](#); [Maier et al., 2025](#)). Experts also noted that top tab bars can help reduce accidental taps from children's palms on smaller screens.

FGD results further refined these insights. Younger children were easily distracted by Duolingo ABC's horizontally scrollable level map, often exploring decorative level icons rather than accessing the intended lesson. In BOOKR Class, all participants gravitated toward the banner's featured book rather than navigating through the full menu. Recognition of icons also varied by age: older children could interpret most tab-bar icons, while the youngest participant struggled with abstract symbols, making more mistakes in identifying their meanings. These observations reinforce that minimal steps, clear iconography, and visible pathways enhance usability for early readers and pre-literate users.

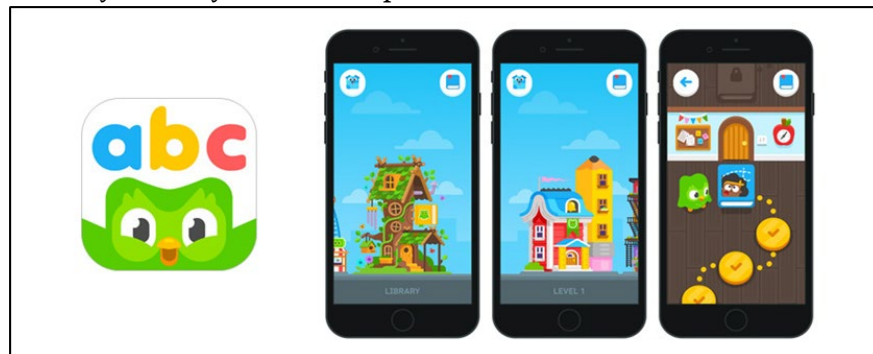


Figure 2 Duolingo ABC Home Page without Navigation Menu

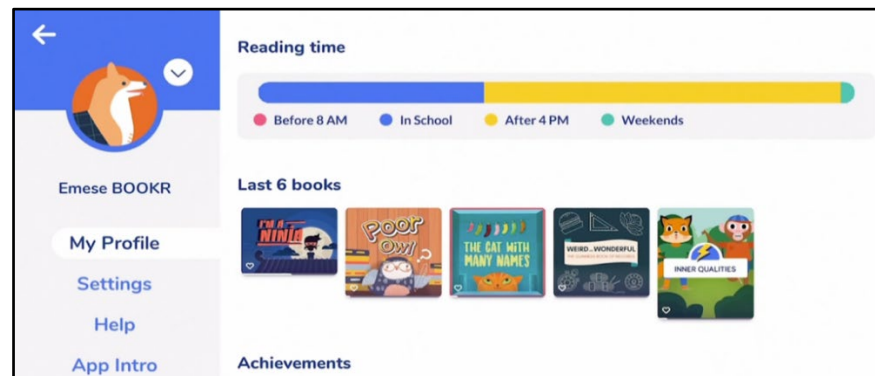


Figure 3 BOOKR Class Home Page with structured Navigation Menu

Color

Color strongly influences emotion and attention. Duolingo ABC's vibrant primary palette (blue, red, yellow, green, and purple) aligns with findings that saturated and high-contrast colors as optimal for sustaining attention and literacy engagement (Lyu et al., 2022; Pei et al., 2023; Nie et al., 2024). In contrast, BOOKR Class employs a more restrained, cool-toned palette that promotes calmness and focus during reading activities, reflecting the importance of context-sensitive color harmony (Jayanti & Meilinda, 2018).

Experts insights added nuance by noting that color usage should be case-by-case, depending on app purpose. While more varied colors can improve engagement for younger learners, educational apps do not always require the same vibrancy expected in entertainment-oriented platforms. All experts also stressed that device contrast and ambient lighting remain important considerations to prevent overstimulation.

FGD findings showed that both apps' bright color schemes were engaging, but children consistently favored Duolingo ABC's palette. Further patterns emerged in BOOKR Class: younger children were drawn toward bright, saturated book thumbnails, whereas older children chose darker or muted tones that reflected their personal preferences or interests. These observations, are consistent with prior findings that color perception and preference shift with age, context, and content type (Guo et al., 2019).

Typography

Typography determines not only readability but also influences learning engagement and cognitive processing. Research consistently shows that sans-serif fonts enhance readability in digital media and reduce visual fatigue (Riana & Yulianto, 2026; Li et al., 2024; Nguyễn & Dinh, 2025). Both applications successfully apply this principle by using large fonts (≥ 16 pt), strong contrast, and consistent spacing. Duolingo ABC's rounded typeface conveys friendliness, as shown in Figure 4, while BOOKR Class maintains uniform typography across story pages to support narrative immersion, as shown in Figure 5.

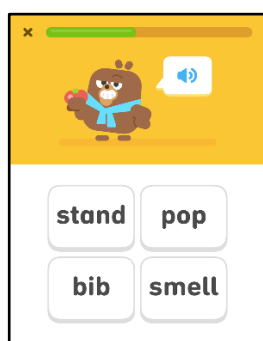


Figure 4 Duolingo ABC Typography

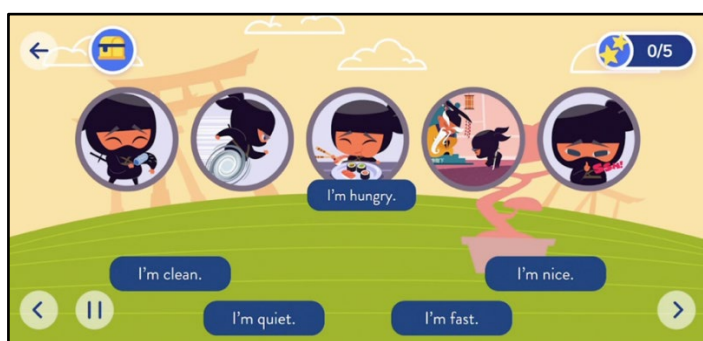


Figure 5 BOOKR Class Typography

Experts emphasized that typography decisions should remain context-sensitive. While readability must be prioritized, serif fonts may be used selectively in thematic contexts such as mystery or historical narratives, where visual atmosphere contributes to storytelling. This suggests that typography can function not only as a readability tool but also as a narrative and pedagogical device when applied appropriately.

FGD findings provide further insight into how typography affects early learning. While older children showed minimal differences in reading speed across typefaces, the youngest participant experienced noticeable delays when reading serif text. At the same time, most children reported not consciously noticing differences in

readability, suggesting that perceived ease does not always reflect actual processing efficiency. This can be explained by the development of early reading automaticity, in which children process familiar letterforms with limited conscious awareness while focusing primarily on meaning rather than visual form (Rahmawati & Handayani, 2023).

For early readers whose decoding skills are still developing, reliance on clear and simplified letterforms becomes more pronounced, making typographic clarity a critical factor in supporting word recognition and reading fluency. Consequently, well-designed typographic choices function as a pedagogical support that can enhance early literacy outcomes, particularly when aligned with developmentally appropriate and adaptive design approaches (Pratama & Mahendra, 2025).

Building on these findings, the use of short-duration FGD sessions may not fully capture subtle differences in typographic processing, indicating a methodological limitation in assessing deeper perceptual responses. Despite this limitation, the overall patterns observed reinforce the role of typography as a pedagogical support element rather than merely a visual component. The use of simple, high-legibility typefaces can facilitate early literacy development by reducing cognitive load during reading tasks. At the same time, adaptive typography—such as adjustable font size and spacing—remains essential to accommodate varying levels of reading ability and support inclusive learning environments (Alabdulkader et al., 2021).

Icons and Illustrations

Icons and illustrations function as both emotional and instructional cues. Duolingo ABC's mascots, Duo and Junior as seen in Figure 6 act as parasocial companions providing feedback and motivation, aligning with prior findings (Outhwaite et al., 2023; Sudina et al., 2025). BOOKR Class, lacking a consistent in-app mascot, relies more on story illustrations to engage learners as seen in Figure 7.

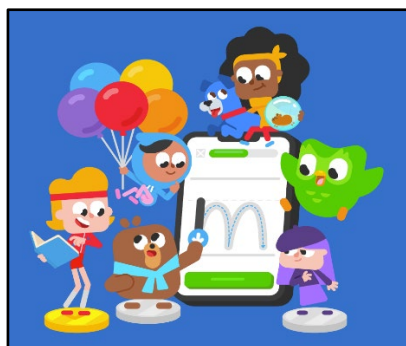


Figure 6 Duolingo ABC Typography



Figure 7 BOOKR Class Bunny Character

Experts clarified that mascots are not a requirement for educational apps; their use is more closely tied to branding than functional interactivity. If an app already contains strong main characters, such as story protagonists, these characters may effectively substitute for a separate mascot. Additionally, they noted that icon comprehension varies depending on age and icon complexity: simple icons (e.g., “back”) are universally understood, whereas abstract icons (e.g., “history”) may require textual support

FGD findings reinforced this distinction. Younger children showed strong enthusiasm toward Duolingo ABC's mascots, especially Junior's daily jokes and expressive animations, which enhanced emotional enjoyment but did not necessarily translate into learning motivation for older children. The youngest participant reported wanting to open the app daily because of the mascot, while still not yet associating mascot interaction with accessing lessons. This supports findings that parasocial elements enhance emotional engagement, particularly for early learners,

though the functional impact varies by age (Febrillian & Aestetika, 2024; Hellín et al., 2023).

DISCUSSION

Based on the integrated findings from the literature review, application analysis, expert interviews, and focus group discussions (FGD), this study synthesizes the empirical and theoretical insights into an evidence-based conceptual framework for child-centered interface design in early language learning applications. The framework addresses the need to align interface design with children's cognitive, emotional, and aesthetic characteristics while maintaining educational effectiveness. It emphasizes three core principles—cognitive simplicity, emotional resonance, and context-sensitive design decisions—and translates these principles into flexible, developmentally appropriate recommendations. Table 2 summarizes these principles and presents actionable design framework derived from the study's findings.

The comparative findings are synthesized into a conceptual framework illustrated in Figure 8, which integrates three interrelated design dimensions: cognitive manageability, emotional engagement, and aesthetic clarity. These dimensions are derived from the actionable principles outlined in Table 2, translating the detailed design framework that guides the development of child-centered learning interfaces. Rather than functioning as a prescriptive checklist, the framework reflects observed behavioral patterns of children and contextual insights from expert validation. It highlights how navigation structure, color strategy, typography, and visual symbolism collectively support comprehension, motivation, and sustained interaction in early language learning environments.

This framework promotes a human-centered perspective that designs with children rather than merely for them. By integrating empirical observations, expert perspectives, and user validation, the model positions visual communication design as an active pedagogical component within educational technology, supporting developmentally appropriate, emotionally supportive, and instructionally meaningful digital learning experiences.

Taken together, the findings indicate that optimizing user interface design for child-centered language learning applications requires balancing cognitive clarity, emotional engagement, and aesthetic simplicity within developmentally appropriate interaction structures. Effective interfaces do not rely on uniform visual rules but adapt navigation pathways, color strategies, typography, and symbolic cues to children's developmental stages and learning contexts. The proposed framework therefore offers a structured yet flexible approach that aligns interface design with children's cognitive processing, emotional responses, and aesthetic preferences while maintaining educational effectiveness.

This framework offers practical guidance for early childhood educators in Indonesia in selecting and evaluating digital learning applications, for local developers in designing more pedagogically aligned interfaces, and for policymakers in strengthening the national digital learning agenda. By emphasizing developmentally appropriate and child-centered design, the framework supports ongoing efforts to integrate digital technology into early education in ways that enhance learning quality rather than merely increasing technological adoption.

Table 2 Proposed Child-Centered UI Design Framework for Educational Applications

UI Component	Design Principle	Empirical Basis (Findings & Citations)	Practical Recommendation for Designers
Navigation	Cognitive simplicity	Children navigate most effectively when core content is reachable within fewer than three steps, and consistent layouts reduce working memory load (Latiff et al., 2019; Norouzi et al., 2021).	Use clear, consistent pathways; prioritize bottom menus for mobile and top bars for larger screens (Xie et al., 2015) Limit scrolling or provide explicit visual cues. Support younger users with simple, highly recognizable icons; pair complex icons with text labels.
Color	Emotional engagement through harmony	Bright, high-contrast colors sustain attention (Lyu et al., 2022; Pei et al., 2023), while over-saturation can cause distraction (Kurniawan et al., 2021; Guo et al., 2019).	Apply vibrant yet controlled palettes; adjust tone based on age range and learning goals. Combine warm and cool hues to balance excitement and calm. Ensure adequate contrast for readability, and avoid excessive stimulation in reading-focused contexts.
Typography	Legibility and inclusivity	Empirical studies affirm that large sans-serif fonts (≥ 16 pt) increase reading accuracy and comfort (Li et al., 2024; Nguyễn & Dinh, 2025); adaptive typography supports accessibility (Alabdulkader et al., 2021; Martens et al., 2018; Avenido et al., 2025).	Use large, rounded sans-serif fonts for general content; maintain strong contrast and generous spacing. Introduce serif typefaces only when thematically appropriate and ensure readability is not compromised. Incorporate adjustable text sizes for inclusive access.
Icons & Illustrations	Emotional guidance and visual clarity	Parasocial mascots improve engagement and comprehension (Outhwaite et al., 2025; Sudina et al., 2025); recognizable icons facilitate faster learning (Taylor et al., 2022).	Use familiar, culturally relevant symbols; support abstract icons with text labels. Employ mascots only when they serve a meaningful instructional or engagement purpose. Use gesture-based or animated feedback to support younger children's emotional and cognitive cues.

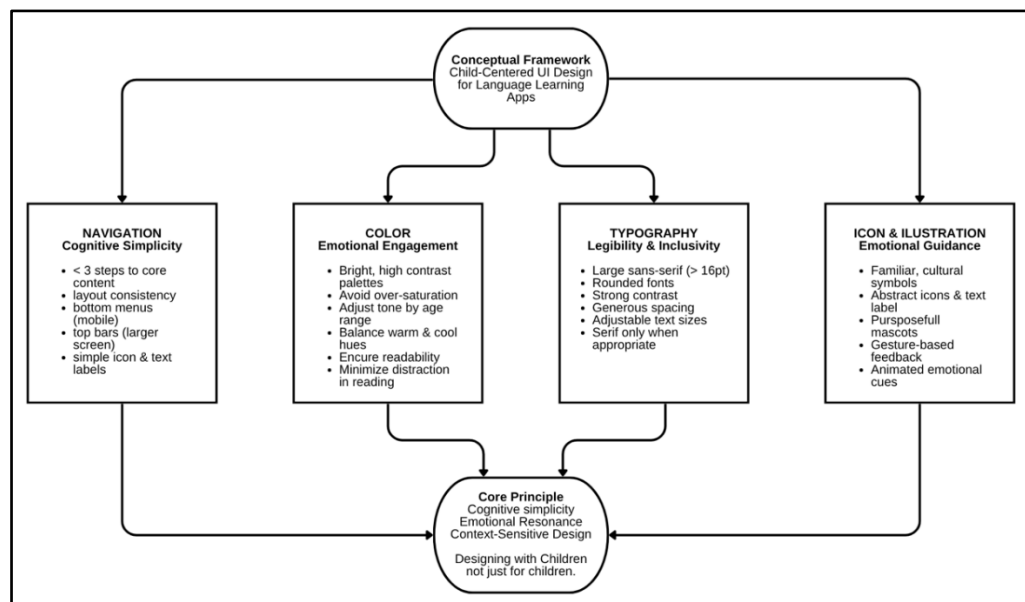


Figure 8 Conceptual Framework for Child-Centered Interface Design in Early Language Learning Applications

CONCLUSION

User interface (UI) design in child-centered language learning applications extends beyond visual presentation, functioning as a critical mediator in how children engage with and understand learning content. The findings of this study emphasize that interface elements must be developmentally responsive, as children at different ages demonstrate distinct interaction patterns, attention strategies, and levels of cognitive processing. This highlights the need for adaptive rather than standardized design approaches in educational applications.

The study also reveals that while certain interface components, such as navigation structure and typographic clarity, consistently support efficient interaction, other elements—particularly color usage and visual symbolism—require contextual sensitivity to effectively balance engagement and comprehension. These results reinforce the view that interface design should be approached as an integral part of the learning process, shaping not only usability but also the quality of learning experiences.

In practical terms, these insights are especially relevant within the Indonesian educational landscape, where digital learning tools are increasingly integrated into both classroom and home environments. Applying child-centered and developmentally informed design strategies can support more inclusive and effective learning experiences, particularly in early literacy development. In this context, the study also highlights the importance of interdisciplinary collaboration among educators, designers, and technology developers to ensure that digital learning applications are not only technically functional but also pedagogically meaningful and developmentally appropriate for children.

More broadly, this study contributes to the national digital learning agenda by providing evidence-based guidance for improving the quality of educational applications used in early childhood education. It encourages alignment between classroom practices, local technology development, and policy-level initiatives aimed at expanding digital literacy and equitable access to learning resources across Indonesia.

This study is limited by its focus on a small group of participants and a restricted number of applications, which may not fully capture the diversity of user experiences within the broader educational technology context. Furthermore, the scope is confined to early language learning. In addition, the use of short-duration FGD sessions may not fully capture subtle differences in children's cognitive and perceptual responses, particularly in aspects such as typographic processing. While the study integrates design and educational perspectives, its interdisciplinary scope remains limited, as it does not yet fully incorporate insights from fields such as developmental psychology or learning sciences.

Future research should expand the range of applications studied, include more diverse participant groups, and explore iterative co-design approaches involving children as active contributors. It is also recommended that future studies adopt interdisciplinary approaches by integrating perspectives from education, psychology, and design to develop more holistic and context-sensitive learning applications. Such directions are essential to further strengthen the role of interface design in supporting meaningful, engaging, and pedagogically effective digital learning environments.

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CONFLICT OF INTEREST

The author hereby declares that this research is free from conflicts of interest with any party

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