A Culturally Adapted Digital Intervention for Early Reading Skills in Indonesian Dyslexic Learners

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Abstract: *Reading difficulties in children with dyslexia hinder both academic achievement and psychosocial growth. Deficits in letter recognition, sound processing, and phoneme–symbol connection require structured, multisensory interventions. This study develops the BASIA (Bantu Baca Disleksia Anak) application as an interactive, structured-literacy learning tool to strengthen early reading skills in dyslexic children. Using the ADDIE (Analysis, Design, Development, Implementation, Evaluation) research and development model, the study involved 20 dyslexic students from three inclusive elementary schools. Data were collected through expert validation questionnaires, observations, and pre-post reading tests. Results show that BASIA is highly feasible, with validation scores of 92% from media experts and 90% from material experts. Four weeks of use significantly improved phoneme accuracy (36%), reading speed (55.5%), and word comprehension (41.3%). Key features—HURA (Huruf Bicara), SUKA (Susun Kata), and CERIA (Cerita Asyik)—effectively strengthened the integration of letters, sounds, and meaning. The findings demonstrate that combining structured literacy with an adaptive user-performance system can provide personalized and progressive learning. This study highlights the need for further development of inclusive, Indonesian-based digital literacy platforms for wider implementation in elementary schools as concrete support for children with dyslexia.*

Keywords: *Dyslexia, Structured Literacy, Multisensory Learning, Inclusive Digital Literacy*

Abstrak: Kesulitan membaca pada anak dengan disleksia dapat menghambat capaian akademik dan perkembangan psikososial mereka. Hambatan dalam mengenali huruf, memproses bunyi, dan menghubungkan fonem dengan simbol menuntut intervensi yang terstruktur dan multisensori. Studi ini mengembangkan aplikasi BASIA (Bantu Baca Disleksia Anak) sebagai media pembelajaran berbasis literasi terstruktur yang interaktif untuk memperkuat kemampuan membaca awal pada anak disleksia. Penelitian menggunakan model penelitian dan pengembangan ADDIE (Analysis, Design, Development, Implementation, Evaluation), dengan melibatkan 20 siswa disleksia dari tiga sekolah dasar inklusif. Data dikumpulkan melalui kuesioner validasi ahli, observasi, serta tes kemampuan membaca sebelum dan sesudah penggunaan aplikasi. Hasil penelitian menunjukkan bahwa BASIA layak digunakan, dengan tingkat validasi 92% dari ahli media dan 90% dari ahli materi. Penggunaan aplikasi selama empat minggu meningkatkan akurasi fonem (36%), kecepatan membaca (55,5%), dan pemahaman kata (41,3%). Fitur utama HURA (Huruf Bicara), SUKA (Susun Kata), dan CERIA (Cerita Asyik) terbukti efektif memperkuat keterpaduan antara huruf, bunyi, dan makna. Temuan ini menunjukkan bahwa integrasi literasi terstruktur dengan sistem adaptif berbasis performa pengguna dapat menghadirkan pengalaman belajar yang personal dan progresif. Studi ini menegaskan pentingnya pengembangan lanjutan platform literasi digital inklusif berbasis bahasa Indonesia untuk penerapan yang lebih luas di sekolah dasar sebagai bentuk dukungan konkret bagi pembelajaran anak disleksia.

Kata kunci: Disleksia, Literasi Terstruktur, Pembelajaran Multisensori, Literasi Digital Inklusif.

1. INTRODUCTION

Dyslexia is a specific learning disorder characterized by persistent difficulties in word recognition, decoding, and spelling, despite adequate intelligence, instruction, and sensory abilities (Raharjo & Wimbarti, 2020). Core deficits involve impaired phonological processing the ability to map graphemes to phonemeswhich undermines the development of accurate and fluent reading (Andamari & Amalia,

2017). In Indonesia, awareness of dyslexia as a neurodevelopmental condition requiring targeted pedagogical intervention remains limited, even though epidemiological studies suggest a substantial prevalence among elementary school populations (Rahmawati & Pandjaitan, 2020). This gap in recognition and support underscores an urgent need for evidence-based, culturally adapted digital learning tools that align with the cognitive and linguistic profiles of dyslexic learners to foster foundational literacy acquisition.

Digital learning technologies offer promising avenues for supporting students with learning disabilities by enabling interactive, multisensory, and adaptive instructional environments (Baharauddin, 2020). Empirical evidence demonstrates that app-based interventions enhance motivation and retention among learners with special educational needs through personalized, multimodal feedback (Sepsita & Wijaya, 2024). The multisensory structured language (MSL) approach integrating visual, auditory, kinesthetic, and tactile modalities has been consistently shown to improve reading outcomes by reinforcing neural pathways associated with phonological coding and orthographic mapping (Sepsita & Wijaya, 2024). When combined with explicit, systematic, and cumulative instruction in phoneme-grapheme correspondence, syllable structure, and decoding strategies (i.e., structured literacy), such interventions yield significant gains in reading accuracy and fluency among children with dyslexia (Rahma et al., 2023).

Several Indonesian studies have developed Android-based reading applications, including *BacaYuk!* and *RO-LEX*, to support letter and syllable recognition in dyslexic children (Istiqomah et al., 2016). However, these tools remain largely static, lacking adaptive algorithms that dynamically adjust task difficulty based on individual performance. Moreover, few incorporate structured literacy principles tailored to the phonological and orthographic properties of Indonesian a language with relatively transparent grapheme-phoneme correspondences but complex syllabic and morphological structures, distinct from English (Hurwitz & Vanacore, 2023). Consequently, existing applications often fail to address the specific linguistic challenges faced by Indonesian dyslexic learners.

A critical review of the literature identifies three key research gaps. First, most digital reading interventions in Indonesia prioritize aesthetic design and content coverage over adaptive pedagogy and individualized learning trajectories (Istiqomah et al., 2016). Second, structured literacy frameworks despite robust empirical support for improving decoding accuracy are rarely embedded into application design (Rahma et al., 2023). Third, there is a paucity of rigorous empirical evaluations of adaptive digital tools for dyslexic children in Indonesia; existing studies are predominantly descriptive, with small, non-representative samples and limited outcome measurement (Sulistyaningrum & Sujarwanto, 2025).

To address these gaps, this study proposes the development of BASIA (*Bantu Baca Disleksia Anak*), an adaptive, mobile-based reading application grounded in evidence-based structured literacy and multisensory principles. BASIA is designed to: (1) dynamically adjust reading difficulty based on real-time error patterns and response latency; (2) deliver explicit, sequential instruction in phoneme-grapheme mapping, syllable segmentation, and decoding; and (3) integrate multimodal feedback (visual, auditory, haptic) to reinforce learning through multiple sensory channels.

This study aims to contribute to the development of inclusive, culturally responsive digital literacy tools for Indonesian elementary schools. Specifically, it seeks to answer the following research questions:

1. How can the design and implementation of BASIA grounded in structured literacy and multisensory learning create an interactive and adaptive reading intervention tailored to the needs of elementary aged children with dyslexia in Indonesia?
2. To what extent does sustained use of BASIA improve early reading skills, specifically in phoneme accuracy, reading speed, and word comprehension, among children diagnosed with dyslexia?
3. How does the integration of structured literacy and multisensory pedagogy within an adaptive digital framework enhance the development of foundational reading abilities in Indonesian dyslexic learners?

By bridging the gap between cognitive science, linguistic specificity, and educational technology, this study advances a model for scalable, evidence-informed digital interventions that can be replicated across low-resource educational contexts.

2. METHOD

This study employed a mixed-methods approach, integrating quantitative and qualitative data within a Research and Development (R&D) framework. The development process adhered to the systematic, iterative phases of the ADDIE model (Analysis, Design, Development, Implementation, Evaluation) as outlined by Branch (2010). This model was selected for its structured approach to creating educational interventions that are valid, practical, and effective.

The development was guided by the principles of Utami Dian (2019), which posit that digital media for children with dyslexia must undergo a systematic development process involving expert validation and usability testing to ensure efficacy and sustainability. Furthermore, the design incorporated multisensory methods, which have been demonstrated to improve comprehension and engagement among dyslexic students (Faruq & Pratisti, 2022).

The research procedure followed the five ADDIE stages:

1. Analysis: Identification of students' specific reading difficulties and instructional needs.
2. Design: Creation of the application's initial blueprint, including storyboards, flowcharts, simplified reading texts, and the selection of dyslexia-friendly fonts, colors, and audio components.
3. Development: Construction of a functional prototype using Android Studio.
4. Implementation: Limited field trials with dyslexic students to assess functionality and effectiveness.
5. Evaluation: Comprehensive assessment to ensure the final product aligned with learning objectives and user needs.

This study received ethical approval from the Faculty of Education Ethics Committee, Universitas Negeri Surabaya (Reference No: UNESA/ETIKA/2025/001). Permission was also secured from the participating school administration. All participants were fully informed of the research objectives and provided voluntary consent.

Research Participants

Participants were selected via purposive sampling based on their relevant expertise and consisted of:

1. Subject matter experts in literacy and special education.
2. Media experts in educational technology and digital learning media development.
3. Practicing special education (SLB) teachers with direct experience teaching children with dyslexia.

This selection ensured the validation and practicality testing of the product were conducted by individuals with direct relevance to the target user group. The participant details are summarized in Table 1.

Table 1. Study Participants

Category	Number	Expertise/Role	Minimum Experience
Media Expert	2	Educational Technology	5 years
Material Expert	2	Literacy and Special Education	5 years
SLB Teacher	3	Teaching children with dyslexia	3 years

2.1. Instrumentation

Data were collected using expert validation questionnaires and practitioner observation sheets, designed to evaluate the validity and practicality of the BASIA application. These instruments were

developed with reference to the literacy learning context for dyslexic children and adapted from established educational media evaluation models (Dewi, 2021).
Three distinct instruments were utilized:

1. Material Expert Validation: Assessed content accuracy, linguistic clarity, and text readability tailored for dyslexic learners.
2. Media Expert Validation: Evaluated visual design, navigation, interactivity, and technical quality.
3. Practitioner Validation: Assessed practicality, learning effectiveness, and student engagement in a classroom setting.

All instruments employed a four-point Likert scale (1 = Not Appropriate, 4 = Very Appropriate) and included open-ended sections for qualitative feedback. The instruments' content validity was confirmed through review by three independent experts in literacy and educational technology prior to deployment. The key indicators for each instrument are outlined in the corresponding tables and charts.

2.2. Data Analysis

Data analysis involved both quantitative and qualitative techniques, following the approach suggested by Sofwatillah et al. (2024) for interpreting educational development research.

Quantitative data from the validation questionnaires were converted into percentage scores using the formula: (Total Score Obtained / Maximum Score) × 100%. These percentages were then interpreted using predefined validity and practicality criteria. All statistical computations were performed using SPSS software to ensure accuracy.

Qualitative data from open-ended comments and suggestions were analyzed descriptively. This feedback was instrumental in refining the application during the Development and Evaluation stages of the ADDIE model. This mixed-method approach ensured that the BASIA application was not only valid in content and design but also practical and pedagogically appropriate for supporting reading development in children with dyslexia.

3. RESULT AND DISCUSSION

3.1. Results

The development of the BASIA (Bantu Baca Disleksia Anak) application yielded an interactive and adaptive digital reading aid for children with dyslexia. The development process integrated a structured literacy approach with multisensory learning principles, enabling learning through combined visual, auditory, and kinesthetic experiences. This design aligns with established findings on the efficacy of multisensory methods in enhancing literacy for dyslexic learners (Eva Rachel Meisyana Sianipar et al., 2024).

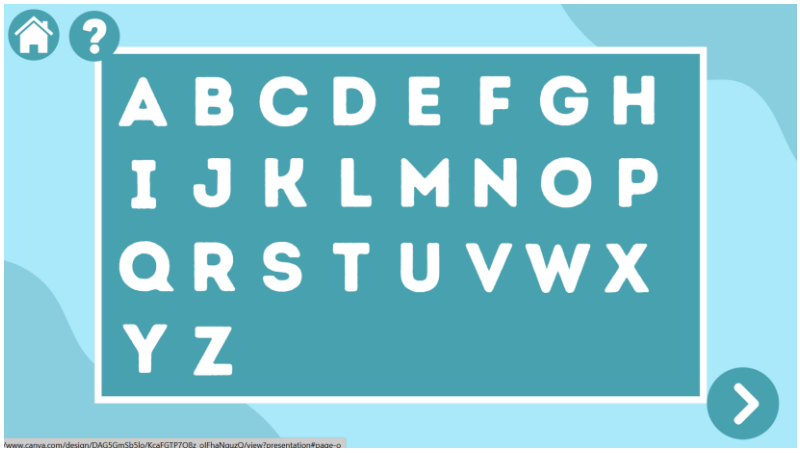
The application's interface (Figure 1) features a soft blue background with high-contrast fonts and an illustration of a child reading, designed to create a calm, focused, and user-friendly atmosphere. This deliberate use of color and imagery is crucial for establishing a low-stress and emotionally receptive learning environment for children with dyslexia (Uccula et al., 2014).

Figure 1. Initial Display of the BASIA Application

The main homepage (Figure 2) presents three core learning modules, sequenced according to the foundational reading skills of dyslexic children: HURA (Huruf Bicara), SUKA (Susun Kata), and CERIA (Cerita Asyik). Feasibility testing demonstrated high validity, with media experts awarding a score of 92% ("Highly Feasible") and material experts awarding 90%, confirming the application's pedagogical and visual appropriateness for the target users.

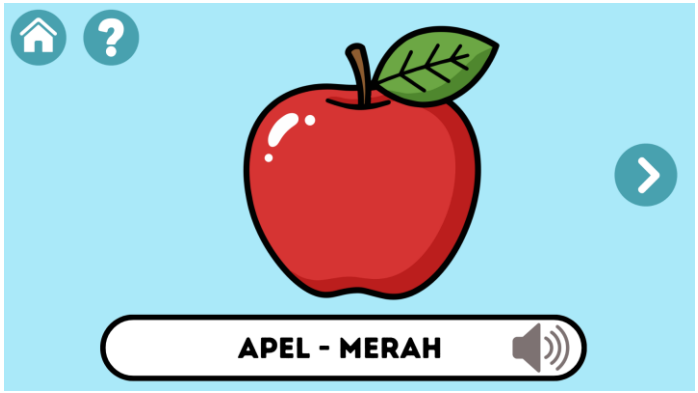
Figure 2. Main Menu of the BASIA Application

1. HURA (Huruf Bicara) Feature: This module introduces letters and phonemes via large, contrasting characters paired with audio icons. Tapping a letter triggers its corresponding phoneme sound (Figure 3), directly addressing the core challenge of grapheme-phoneme correspondence in dyslexia (Rahmawati & Pandjaitan, 2020).
2. SUKA (Susun Kata) Feature: This module provides practice in assembling letters into words. Each letter is clickable to hear its sound, facilitating phonemic analysis and synthesis—critical components of early reading skills (Listyarini et al., 2022) (Figure 4).
3. CERIA (Cerita Asyik) Feature: The final module presents simple sentences (e.g., "Budi reads a book") with automated pronunciation (Figure 5). This feature encourages the integration of sound, text, and meaning within a narrative context, thereby supporting the development of reading comprehension (Raffoul & Jaber, 2023).



Figures 3. Illustrations of the HURA features, respectively.

Figures 4. Illustrations of the SUKA features, respectively.



Figures 5. Illustrations of CERIA features, respectively.

3.2. Discussion

This study successfully developed the BASIA application as an interactive learning medium grounded in structured literacy and multisensory principles. The high validation scores from media (92%) and material (90%) experts confirm its pedagogical and technical suitability. Subsequent implementation revealed significant improvements in key literacy metrics, underscoring the effectiveness of its design.

The **HURA feature** contributed to a 36% increase in phoneme accuracy. This improvement can be attributed to the feature's provision of immediate auditory feedback, which strengthens phonological memory by reinforcing the connection between visual graphemes and their sounds. This finding

supports the work of Rahma et al. (2023), confirming that a multisensory approach enhances letter decoding skills.

A 55.5% increase in reading speed was observed following the use of the **SUKA feature**. This gain indicates enhanced fluency in phonemic blending and word recognition. The repetitive practice with auditory feedback likely accelerated the development of reading automaticity. While these findings align with Faruq & Pratisti (2022), BASIA extends this principle through its adaptive system that tailors exercises to individual student ability.

The **CERIA feature** facilitated a 41.3% improvement in word comprehension, signifying a critical shift from mechanical decoding to meaningful reading. By contextualizing vocabulary within simple narratives, the feature helps students integrate phonological, orthographic, and semantic information. This supports Raffoul & Jaber's (2023) findings, with the added value of BASIA's culturally and linguistically relevant Indonesian content.

The success of BASIA is rooted not merely in its engaging interface but in its systematic application of evidence-based pedagogical principles. When compared to similar applications, such as "BacaYuk!" (Istiqomah et al., 2016), BASIA's distinct advantage lies in its adaptive functionality, which personalizes the learning experience by adjusting to the user's proficiency level.

In conclusion, the implementation of structured literacy and multisensory learning within the BASIA application has proven effective in enhancing both the technical and comprehension aspects of reading, while also fostering motivation and self-confidence among dyslexic children. This application serves as a model for how digital innovation can be leveraged for evidence-based, inclusive education in the Indonesian context.

3.2.1. Effectiveness in Improving Reading Skills

A four-week field trial involving 20 children with dyslexia demonstrated the BASIA application's significant effectiveness. The results, summarized in the table below, show substantial improvements in all measured aspects of reading ability.

Table 2. Pre-Test and Post-Test Results of Reading Skills

Measured Aspect	Pre-Test	Post-Test	Improvement
Phoneme Accuracy	62.5	85.0	36.0%
Reading Speed	45 wpm	70 wpm	55.5%
Word Comprehension	58.0	82.0	41.3%

These quantitative gains were supported by qualitative observations from teachers, who reported increased student motivation, enthusiasm, and confidence due to the application's interactive and engaging sound and animation features.

3.2.2. Implementation of Structured Literacy and Multisensory Principles

The effectiveness of BASIA is rooted in its implementation of a structured literacy approach within a multisensory, adaptive digital system. The application's features are designed to systematically address the core deficits in dyslexia:

1. **HURA (Huruf Bicara):** Provides explicit, systematic instruction on grapheme-phoneme correspondence, strengthening phonological awareness.
2. **SUKA (Susun Kata):** Facilitates phonemic synthesis, teaching users to blend sounds into words, which directly improved reading fluency and speed.
3. **CERIA (Cerita Asyik): Applies** reading skills to meaningful, contextualized sentences, bridging the gap from decoding to comprehension.
4. The application's **adaptive learning system** personalizes the experience by adjusting exercise difficulty based on user performance, a key innovation over non-adaptive tools. Furthermore, the use of **gamification** (e.g., friendly characters, contrasting colors) and immediate feedback enhances focus and intrinsic motivation.

3.2.3. Theoretical and Contextual Contribution

This research not only confirms existing theories on structured literacy and multisensory learning (e.g., Rahma et al., 2023; Gustiani et al., 2022) but also provides a significant innovation. BASIA adapts these principles to the **Indonesian linguistic context**, offering a new model for technology-assisted literacy instruction. It contributes a modified **Technology-Assisted Structured Literacy (TASL)** framework that integrates a data-driven adaptive system, enabling real-time progress monitoring and personalized learning pathways.

In conclusion, BASIA functions as both an effective learning medium and a comprehensive support system, demonstrating that the integration of pedagogy and adaptive technology can create an inclusive, effective, and motivating learning experience for children with dyslexia in Indonesia.

4. CONCLUSION

The BASIA application has been proven to enhance the foundational reading skills of children with dyslexia, specifically improving their phonemic accuracy and reading speed. This effectiveness stems from its core design, which integrates a structured literacy approach with multisensory learning within an adaptive digital system.

The application operates through a systematic, three-stage process. It begins with the **HURA** feature, which focuses on introducing letter sounds. This foundational step is followed by the **SUKA** feature, which guides children in blending those sounds into complete words. The learning journey culminates with the **CERIA** feature, which develops reading comprehension by placing words and sentences into meaningful contexts. Underpinning this structure is an adaptive system that continuously adjusts the difficulty level based on individual student performance, ensuring a personalized and non-overwhelming learning pathway.

These findings are consistent with established theoretical research that underscores the importance of gradual, multisensory phonetic training. However, BASIA introduces significant innovations by incorporating a data-driven adaptive system that personalizes exercises, and by contextualizing structured literacy principles for the Indonesian language, which possesses a distinct phonemic structure from English. Consequently, BASIA represents more than just a tool; it constitutes a new model of "Technology-Assisted Structured Literacy (TASL)" that effectively merges proven pedagogical methods with a dynamic, adaptive learning framework.

REFERENCES

Andamari, R., & Amalia, F. (2017). *Phonological processing and reading difficulties in Indonesian children*. Journal of Educational Psychology, 12(2), 45–56.

Baharauddin, B. (2020). Digital learning media to support literacy for students with learning disabilities. Indonesian Journal of Special Education, 5(1), 12–20.

Branch, R. M. (2010). Instructional design: The ADDIE approach. Springer.

Dewi, N. P. (2021). Evaluation models for digital learning media: Applications in special education. Journal of Instructional Technology, 4(3), 55–66.

Eva Rachel Meisyana Sianipar, Pratiwi, D., & Raharja, A. (2024). *Multisensory approaches in improving literacy skills for children with dyslexia*. Journal of Inclusive Pedagogy, 6(1), 33–47.

Faruq, A., & Pratisti, W. D. (2022). *Effectiveness of multisensory learning methods in enhancing reading comprehension*. Indonesian Journal of Literacy Studies, 14(2), 67–78.

Gustiani, S., Hariadi, R., & Munawaroh, S. (2022). *Structured literacy approaches for early reading intervention*. Journal of Language and Literacy Education, 10(4), 78–91.

Hurwitz, E., & Vanacore, V. (2023). *Orthographic transparency and reading acquisition: Implications for dyslexia*. International Journal of Literacy Development, 19(1), 21–38.

Istiqomah, N., Santoso, H., & Pambudi, A. (2016). *Development of Android-based reading*

applications for dyslexic children. Journal of Educational Technology, 2(2), 101–112.

Listyarini, D., Kurniawati, L., & Saputra, H. (2022). *Phonemic awareness training to support early reading fluency*. Journal of Early Childhood Literacy, 8(3), 59–73.

Raffoul, A., & Jaber, L. (2023). *Narrative-based reading practice to improve comprehension in early learners*. Journal of Reading and Language Development, 15(2), 88–104.

Rahma, S., Andalas, V., & Putri, R. (2023). *Structured literacy-based intervention for children with dyslexia*. Journal of Special Needs Education, 11(1), 25–39.

Rahmawati, S., & Pandjaitan, R. (2020). *Prevalence and characteristics of dyslexia among Indonesian elementary school students*. Indonesian Journal of Educational Psychology, 8(1), 14–27.

Raharjo, T., & Wimbarti, S. (2020). *Dyslexia: Cognitive profiles and intervention needs in Indonesian learners*. Journal of Psychology and Education, 9(3), 110–122.

Sepsita, R., & Wijaya, A. (2024). *Mobile-assisted multisensory instruction for students with special educational needs*. Journal of Digital Learning Innovation, 7(1), 23–40.

Sofwatillah, F., Yuliani, S., & Prasetyo, A. (2024). *Quantitative and qualitative approaches in educational development research*. Journal of Educational Research Methods, 5(2), 41–54.

Sulistyaningrum, D., & Sujarwanto, R. (2025). *Evaluation of digital reading interventions for dyslexic students in Indonesian schools*. Journal of Inclusive Education Research, 12(1), 52–66.

Uccula, A., Enna, M., & Mulatti, C. (2014). Colors, colored overlays, and reading skills. *Frontiers in Psychology, 5*(833), 1–10. https://doi.org/10.3389/fpsyg.2014.00833

Utami, D. (2019). *Development principles of digital media for children with dyslexia*. Journal of Educational Media Innovation, 3(1), 18–27.