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Development of the BASIA Application as a Reading Aid for Dyslexic Children

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Abstract: Reading difficulties experienced by children with dyslexia are a learning barrier that significantly impacts academic and psychosocial development. Impairments in the ability to recognise letters, process sounds and connect phonemic symbols require structured and multisensory learning interventions. This article develops the BASIA (*Bantu Baca Disleksia Anak*) application as an interactive, structured literacy-based learning medium that can help dyslexic children improve their early reading skills. The article used a research and development method with the ADDIE (Analysis, Design, Development, Implementation, Evaluation) model. The trial subjects consisted of 20 dyslexic children in three inclusive elementary schools. The instruments used included an expert feasibility questionnaire, observations and pre- and post-application reading ability tests. The results show that the BASIA (*Bantu Baca Disleksia Anak*) application is feasible to use with a validation rate of 92% from media experts and 90% from material experts. Using the application for four weeks significantly improved the reading ability of dyslexic children in the aspects of phoneme accuracy (36%), reading speed (55.5%) and word comprehension (41.3%). Key features such as HURA (*Huruf Bicara*), SUKA (*Susun Kata*) and CERIA (*Cerita Asyik*) have proven effective in strengthening the relationship between letters, sounds and meaning. The study concludes that integrating structured literacy with a user-performance-based adaptive system can create a personalised and progressive learning experience. The implication of this research is the need for further development of inclusive Indonesian-based digital literacy applications that can be widely implemented in elementary education settings as a form of concrete support for the learning of children with dyslexia.
Keywords: BASIA application, dyslexia, structured literacy, multisensory learning, inclusive digital literacy

Introduction

Dyslexia is a specific learning disability that affects an individual's ability to recognise letters, process sounds and comprehend reading text. Children with dyslexia generally have normal or above-average intellectual abilities, but experience significant difficulties in reading, spelling and writing (Raharjo and Wimbarti 2020). The primary obstacle experienced is difficulty connecting letter symbols with their corresponding sounds, which hinders word decoding (Andamari and Amalia 2017). In Indonesia, awareness of dyslexia as a learning disorder requiring special intervention remains relatively low, despite field data indicating a high number of elementary school-aged children exhibiting symptoms of dyslexia (Rahmawati and Pandjaitan 2020). This situation demands innovation in providing learning resources tailored to the cognitive and linguistic characteristics of children with dyslexia so they can optimally develop their literacy skills. Baharauddin (2020) explains that digital technology-based learning has great potential in helping children with special needs develop basic literacy skills through the use of interactive and contextual media. This article shows that app-based learning technology can increase motivation and retention in students with special needs by providing multisensory learning experiences that are adaptive to their characteristics.

With the advancement of digital technology, interactive mobile-based learning media has begun to be widely used to support the learning process of children with special needs. A multisensory approach which combines visual, auditory, kinesthetic and tactile stimulation has been shown to be effective in improving the reading skills of children with dyslexia because it involves multiple sensory pathways in the learning process (Sepsita and Wijaya 2024). This approach can be strengthened by the concept of structured literacy, namely explicit, systematic and gradual reading instruction with a focus on recognizing phonemes, graphemes and the relationship between sounds and letters (Rahma et al. 2023). Several studies in Indonesia have developed Android-based reading aid applications, such as "BacaYuk!" and "RO-LEX" (Istiqomah et al. 2016), which help children with dyslexia recognise letters and syllables. However, most of these applications are static and lack adaptive systems that can adjust the difficulty level of the exercises based on user performance. Furthermore, most of the development of these learning media has not fully integrated structured literacy principles tailored to the phonological characteristics of Indonesian, which has a different phonemic and orthographic structure than English. However, research by Hurwitz and Vanacore (2023)

shows that the integration of adaptive educational technology can significantly improve the literacy skills and learning engagement of students with language barriers. Several assistive technologies have previously been employed to support children with dyslexia, including text-to-speech applications, phonics-based learning software and interactive literacy applications. Previous studies have demonstrated their effectiveness in supporting letter recognition and reading comprehension. However, most existing technologies primarily focus on general reading assistance and have not fully integrated structured literacy principles, multisensory learning and adaptive phonological training based on users' performance patterns. BASIA was developed to address these limitations by providing systematic and progressive phonological exercises tailored to the characteristics of Bahasa Indonesia.

Analysis of various literature reveals several research gaps. First, most research on the development of reading aids in Indonesia still focuses on visual appearance and content without considering adaptability and personalisation of learning (Istiqomah et al. 2016). Second, not many studies explicitly incorporate structured literacy principles into application system design, even though this approach has been proven effective in improving the reading accuracy of children with dyslexia (Rahma et al. 2023). Third, empirical evidence regarding the effectiveness of adaptive digital applications in improving the reading skills of children with dyslexia is still limited, as most previous studies used a descriptive approach with small sample sizes (Sulistyaningrum Yeni, Sujarwanto 2025).

Based on this background and problems, this study proposes the development of the BASIA application, an interactive learning medium based on adaptive structured literacy. This application is designed to adjust the reading difficulty level based on the user's error profile, while providing a progressive and contextual learning experience for children with dyslexia. Therefore, this research is expected to fill the gap in the development of inclusive digital literacy media based on Indonesian and contribute to increasing the effectiveness of early reading interventions for children with dyslexia in inclusive elementary schools. The remainder of this paper is organised as follows: next section presents the literature review and theoretical foundation of the study. The subsequent section describes the research methodology. The findings are then presented and discussed in relation to previous studies, followed by the conclusions,

limitations, and recommendations for future research. The research questions in this study are as follows:

- How can the development of the BASIA application based on structured literacy and multisensory learning become an interactive, adaptive, and effective reading aid for dyslexic children at the elementary school level?
- How effective is the use of the BASIA application in improving the early reading skills of dyslexic children, including phoneme accuracy, reading speed, and word comprehension?
- How can the implementation of a structured literacy approach and multisensory learning through an adaptive digital system in the BASIA application improve the early reading skills of dyslexic children in Indonesia?

Literature Review

Dyslexia: Definition, characteristics and learning implications

Dyslexia is classified as a specific learning disorder that primarily affects phonological abilities, letter recognition and word decoding. Children with dyslexia often have intelligence within the normal range but experience consistent difficulties in reading, spelling and writing, which impacts academic achievement and psychosocial aspects. Research shows that the core problem is often related to impaired phonological processing, namely difficulty identifying and manipulating sounds (phonemes) in words, which hinders the connection between phonemes and graphemes (Raharjo and Wimbarti 2020). The implication for learning practice is that interventions should focus on strengthening phonological abilities, providing explicit and structured instruction, and support that considers the child's motivation and self-confidence (Rahmawati and Pandjaitan 2020).

Structured literacy: Theory and principles

Structured literacy is an explicit, systematic, and sequential approach to reading instruction, focusing on phonological awareness, letter-grapheme recognition, orthographic rules, and decoding and encoding strategies. The main principle of structured literacy is to provide targeted instruction in phonemic skills, grapheme-phoneme connections and morphemic processing in a gradual manner. This approach is often associated with effective intervention programmes for children with reading difficulties (Rahma et al. 2023). Research applying this principle has shown

improvements in decoding accuracy and early comprehension, especially when combined with repetition practice and multimodal feedback.

Multisensory learning for children with dyslexia

Multisensory learning involves the use of visual, auditory, kinesthetic, and tactile stimulation to enhance reading learning. This model aims to utilise alternative sensory pathways so that phonological and graphemic information can be consolidated through more than one channel. Empirical evidence shows that multisensory methods improve motivation, engagement, and learning outcomes in children with dyslexia (Sepsita and Wijaya 2024). In a digital context, features such as high-contrast text, audio pronunciation, touch interactions for word order, and kinesthetic animations are practical implementations of multisensory principles.

Adaptive systems in learning apps: Concepts and potential

Adaptive systems are mechanisms that allow apps to adjust material, difficulty level, and feedback based on user performance. In literacy education, adaptivity can direct practice toward areas of greatest weakness (e.g., specific phonemes), regulate the pace of presentation, and provide recommendations for further practice. Research shows that adaptive learning can increase engagement and learning efficiency, especially in populations requiring individualised intervention, such as children with dyslexia (Hurwitz and Vanacore 2023). A successful implementation of adaptivity must be supported by robust data tracking, error assessment algorithms and clear instructional design to generate meaningful practice recommendations.

Development and evaluation of reading assistance apps in Indonesia

Several studies in Indonesia have developed reading assistance apps for children with dyslexia or other reading difficulties, for example, “BacaYuk!” and “RO-LEX.” These studies report positive impacts on learning interest and letter recognition, but often highlight limitations such as static designs, lack of adaptability and limited integration of structured literacy principles (Istiqomah et al. 2016). Effectiveness evaluations are often conducted on small samples and over short timeframes, so studies with more robust quantitative designs are needed to generalize the results.

Measures of effectiveness

In the reading intervention literature, effectiveness is typically measured across three main domains: phoneme accuracy/word recognition (accuracy), reading speed and fluency (fluency) and comprehension or meaning of reading (comprehension).

Significant improvements in these three domains are considered indicators of a successful intervention programme. Many studies confirm that a combination of phonological training, structured decoding training, and context-based training (short stories) helps improve all three aspects (Gustiani et al. 2022). Valid measurement requires reliable pre-test and post-test instruments and observations of student learning behaviour and motivation.

Summary of Research Gaps and Justification for BASIA Development

A summary of the literature review reveals important gaps: (1) many local applications are still static and not yet adaptive; (2) few applications explicitly integrate structured literacy principles tailored to Indonesian phonology; (3) empirical evaluations are often limited to small samples or descriptive designs. Therefore, developing applications that combine structured literacy, multisensory learning and user-performance-based adaptive systems is a relevant step to address practical needs and close the research gap (Istiqomah et al. 2016). The development of the BASIA application seeks to address this gap by combining these principles and evaluating their impact on phoneme accuracy, reading speed, and word comprehension in children with dyslexia.

Methodology

Research design

The research used a quantitative and qualitative approach with a Research and Development (R&D) model ADDIE (Branch 2010). The ADDIE model was chosen because it provides systematic and iterative steps in developing educational media that are valid, practical and effective in improving learning outcomes. This design was appropriate for producing an adaptive and assistive learning application for children with dyslexia. The research adopted the principles of (Utami Dian 2019), which emphasise that the development of digital media for children with dyslexia must follow a systematic process involving expert validation and usability testing to ensure the effectiveness and sustainability of technology-based learning media. Furthermore, integrating multisensory methods into digital learning applications has been shown to enhance dyslexic students' comprehension and engagement (Faruq and Pratisti 2022). The research procedure followed the ADDIE stages. (1) Analysis: identifying students' reading difficulties and instructional needs. (2) Design: creating the initial design of the application, including the storyboard, flowchart, simple reading texts, and the selection of dyslexia-friendly fonts, colours, and audio. (3) Development: producing a prototype using *Android Studio*. (4)

Implementation: conducting limited trials with dyslexic students to evaluate functionality and effectiveness. (5) Evaluation: ensuring that the final product aligns with learning objectives and user needs. This research has obtained ethical approval from the Faculty of Education Ethics Committee, Universitas Negeri Surabaya (Reference No: UNESA/ETIKA/2025/001). Permission was also granted by the participating school administration, and all participants were informed about the research objectives and voluntarily consented to participate.

Participants

This study involved subject matter experts, media experts and special education teachers who teach children with dyslexia. Subject matter experts were lecturers or special education practitioners who had expertise in basic literacy and learning strategies for children with dyslexia. Media experts were lecturers or practitioners who were experienced in developing digital learning media. Field practitioners are SLB teachers who understand the characteristics and learning needs of children with dyslexia directly in the learning environment. The subject selection technique used purposive sampling, with criteria based on the competence and experience of each party relevant to the research objectives. The research focused on validating and testing the practicality of the product to ensure that the developed application was in line with the characteristics and learning needs of children with dyslexia in special schools and inclusive schools. The participants were aged between 8 and 11 years and exhibited varying levels of phonological reading difficulties. All participants had normal intellectual functioning and experienced difficulties in phoneme recognition, blending and decoding skills. These characteristics were considered during the intervention to ensure that the learning activities matched the participants needs.

Table 1. Participants of the study

Category	Number	Expertise/role	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

Source: Data processes by the researcher, 2026

Data collection

The research instruments consisted of expert validation questionnaires and practitioner observation sheets designed to evaluate the validity and practicality of the BASIA

application. The instruments were developed based on the literacy learning context for children with dyslexia and adapted from validated models of educational media evaluation (Dewi 2021). Three types of instruments were employed: (1) material expert validation, (2) media expert validation and (3) practitioner validation. The material expert validation instrument assessed the content accuracy, linguistic clarity, and text readability adjusted to the characteristics of children with dyslexia. The media expert validation instrument focused on the visual layout, navigation, interactivity and technical quality of the application. The practitioner validation instrument evaluated the practicality, learning effectiveness, and engagement of students during the use of the application in classroom settings. All instruments used a four-point Likert scale (1 = *not appropriate*, 4 = *very appropriate*) and included open-ended comment sections to collect qualitative feedback for product improvement. The instruments were reviewed by three experts in literacy and educational technology to ensure content validity prior to use. To illustrate the structure of the validation instruments, the following figures and tables present the key indicators and aspects assessed by each expert.

Figure 1. Grid of material expert validation instruments

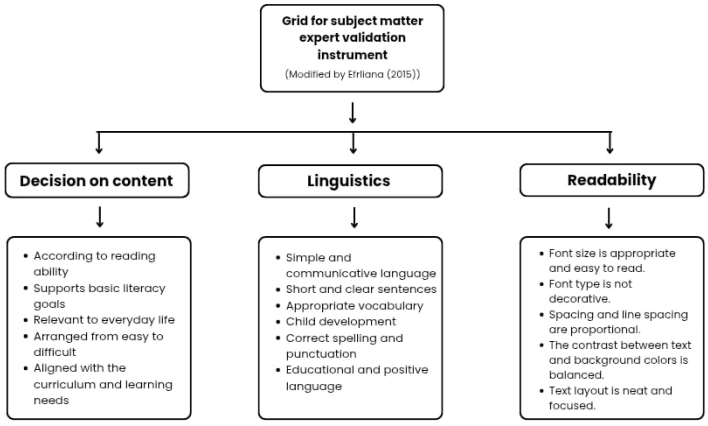
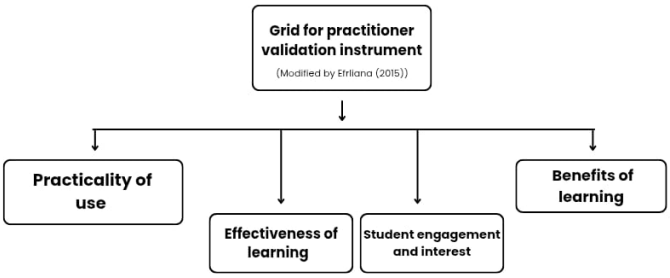


Table 2. Media expert instrument grid

Indicator	Item Number
Visual display	1
Navigation	2
Interactivity	3.4
Visual readability	5
Technical quality	6,7
Quality of motivation	8, 9, 10

Figure 2. Practitioner validation instrument grid



Data analysis

Quantitative and qualitative analyses were employed to determine the validity and practicality of the developed application. The data analysis techniques followed the approach suggested by (Sofwatillah et al. 2024), highlighting the combination of statistical and descriptive methods in interpreting educational development results.

The quantitative data obtained from expert validation was converted into percentage scores using the formula, percentage score (total score obtained ÷ maximum score × 100) which is categorised according to criteria. The resulting percentages were then categorised based on predefined validity and practicality criteria. All statistical calculations were performed using SPSS to ensure accuracy and reliability. The qualitative data from open-ended responses, comments and suggestions provided by material experts, media experts and practitioners were analysed descriptively. These inputs were used to revise and refine the application during the Development and Evaluation stages of the ADDIE model. This combined analysis ensured that the BASIA application was not only valid in terms of content and design, but also practical and pedagogically appropriate for supporting the reading development of children with dyslexia.

Findings and discussion

The research results indicate that the development of the BASIA (Bantu Baca Disleksia Anak) application successfully produced an interactive and adaptive digital reading aid for children with dyslexia. The application development process applied a structured literacy and multisensory learning approach, designed to enable children to learn to read through a combination of visual, auditory and kinaesthetic experiences. This multisensory feature aligns with findings (Eva Rachel Meisyana Sianipar et al. 2024) regarding the effectiveness of this approach in improving literacy in children with

dyslexia. Nevertheless, the present study should be considered a pilot study. Therefore, the findings should be interpreted cautiously due to the relatively small sample size and limited duration of intervention. The initial display of the BASIA application (Figure 1) displays a child reading a book against a soft blue background and contrasting fonts. This design was created to create a calm, focused, and user-friendly impression for children with dyslexia. The colours and characters used play a crucial role in creating a learning environment that is both stress-free and emotionally receptive for children (Uccula et al. 2014).

Figure 1. Initial Display of the BASIA Application

Furthermore, on the main homepage (Figure 2), the application displays three main learning menus arranged in stages according to the basic reading abilities of dyslexic children, namely HURA (Huruf Bicara), SUKA (Susun Kata), and CERIA (Cerita Asyik). The results of the feasibility test by media experts obtained a score of 92% (category “very feasible”), while validation by material experts obtained a score of 90%, indicating that the BASIA application meets the pedagogical and visual criteria appropriate for children with learning disabilities to read.

Figure 2. Main menu of the BASIA application

The HURA (*Huruf Bicara*) feature introduces letters, and phoneme sounds through large, contrasting letters and a sound icon to play the pronunciation. When a child presses a specific letter, the app produces a sound corresponding to the phoneme

(Figure 3). This feature helps children understand the relationship between letter symbols and sounds, a major challenge for children with dyslexia (Rahmawati and Pandjaitan 2020).

Figure 3. HURA feature

The SUKA (*Susun Kata*) feature provides practice in arranging letters into words. Each letter can be clicked to hear its sound, allowing children to learn to combine phoneme sounds into complete words (Figure 4). This feature facilitates phonemic analysis and synthesis, two important aspects of early reading skills (Listyarini et al. 2022).

Figure 4. SUKA feature

The final feature, CERIA (*Cerita Asyik*), displays simple sentences like “Budi reads a book,” accompanied by automated pronunciation (Figure 5). This feature encourages children to connect sound, text and meaning through the context of a short story, thereby helping to improve overall reading comprehension (Raffoul and Jaber 2023).

Figure 5. CERIA Feature

The research results show that the BASIA (Bantu Baca Disleksia Anak) application was successfully developed as an interactive learning medium based on structured literacy and multisensory learning, effectively improving the reading skills of children with dyslexia. Validation by media experts (92%) and material experts (90%) indicated that this application is suitable for use both visually and pedagogically. A 36% increase in phoneme accuracy indicates that the HURA feature effectively helps children understand the relationship between letters and sounds through auditory feedback. This occurs because the combination of visual and auditory input strengthens the phonological memory of children with dyslexia. These results support the findings of (Rahma et al. 2023), that a multisensory approach improves letter decoding skills. A 55.5% increase in reading speed through the SUKA feature indicates that children can combine phonemes into words more fluently. Repeated phonemic practice accompanied by auditory feedback accelerates the development of reading automaticity. These findings align with those of (Faruq and Pratisti 2022), although BASIA excels due to its adaptive system that adapts exercises to the child's abilities. A 41.3% increase in word comprehension through the CERIA feature demonstrates that children are beginning to connect sounds, text, and meaning through the context of simple sentences. This demonstrates a shift from mechanical reading to meaningful reading. These findings support (Raffoul and Jaber 2023), but BASIA offers the advantage of using a more linguistically and culturally relevant Indonesian context. Although the findings indicate positive effects, this study should be considered a pilot study. Therefore, the results should be interpreted cautiously due to the relatively small sample size and short intervention period. Implicitly, these results confirm that BASIA's success stems not only from engaging technology, but also from the application of systematic and adaptive pedagogical principles. When compared to apps like "BacaYuk!" (Istiqomah et al. 2016), BASIA stands out for its ability to adapt to the reading difficulty level and provide a more personalised learning experience. Thus, the implementation of structured literacy and multisensory learning in the BASIA app has proven effective not only in improving technical reading skills but also in building the motivation and self-confidence of children with dyslexia. This application is proof that digital innovation can be adapted for evidence-based inclusive education in Indonesia.

Effectiveness of using the BASIA application

A field trial was conducted on 20 children with dyslexia in five special needs schools (SLB) for four weeks. Each child used the app three times a week for 30–45 minutes per session. Based on initial reading ability measurements, significant improvements were found in phoneme accuracy, reading speed, and word comprehension.

Table 2. Average reading ability results before and after using BASIA

Measured Aspects	Pre-Test	Post-Test	Improvement (%)
Phoneme accuracy	62,5	85,0	36,0
Reading speed	45 words/minute	70 words/minute	55,5
Word comprehension	58,0	82,0	41,3

Source: Data processes by the researcher, 2026

These results indicate that the BASIA app is effective in helping dyslexic children recognize letters and sounds more quickly and increasing their reading speed by up to 55.5%. The accompanying teachers also noted an increase in learning motivation, with children becoming more enthusiastic and confident when reading because the sound and animation features provided a fun learning experience. These findings align with those of (Yulita et al. 2023), which showed that using the Secil app significantly improved dyslexic children's ability to recognise letters of the alphabet, both vowels and consonants, with an average score increase of up to 48.2%. This confirms that integrating technology into phonetics learning can strengthen the reading skills of children with special needs. The results of improved reading skills among BASIA app users align with research by (Gustiani et al. 2022), which demonstrated the effectiveness of multisensory methods in improving the ability to read vowels and consonants.

The results of the study showed that regular use of the BASIA app for four weeks significantly improved the reading ability of children with dyslexia. Based on quantitative data, phoneme accuracy increased by 36%, reading speed by 55.5%, and word comprehension by 41.3%. These findings indicate that the BASIA app is effective in helping children recognize letters and sounds more quickly, read more fluently, and understand the meaning of reading better. The significance of these findings is that the structured literacy and multisensory approaches implemented in the app work effectively to address the main obstacle faced by children with dyslexia, namely difficulty connecting letter symbols with their sounds. Improved reading ability occurs because BASIA combines visual, auditory and kinaesthetic experiences in the learning process,

thereby strengthening children's phonological representations and sound memory. The increased learning motivation observed by teachers during the app's use is also an additional contributing factor. The engaging visuals and interactive animation features make the learning process enjoyable and less stressful. Children who were initially hesitant about reading become more confident because they receive direct feedback from the sounds and images in the app. This suggests that a positive learning environment plays a crucial role in the success of literacy interventions for children with dyslexia.

These results imply that educational technology designed with children's sensory and emotional needs in mind can be an effective learning tool for inclusive education. BASIA not only improves technical reading skills but also strengthens affective aspects such as motivation, attention, and self-confidence. These findings align with research by (Yulita et al. 2023), which showed that the Secil app successfully improved the letter recognition skills of dyslexic children with an average increase of 48.2%. The similarity lies in the effectiveness of using technology in phonetics training. However, the difference is that BASIA explicitly integrates structured literacy principles and provides a gradual practice system that adapts to the child's performance. Furthermore, these research findings support the findings of (Gustiani et al. 2022), who demonstrated that multisensory methods improve vowel and consonant reading skills. The similarity is that both emphasize the importance of visual and auditory stimulation in enhancing phonemic awareness. The difference is that BASIA combines these approaches in an adaptive digital application format, which allows for unlimited repetition and automatic feedback, resulting in more consistent results.

Thus, these findings confirm that implementing adaptive structured literacy based on digital technology can be an effective strategy for improving basic literacy in children with dyslexia. BASIA's success demonstrates that integrating pedagogy and technology not only accelerates reading mastery but also creates a more inclusive, enjoyable, and meaningful learning experience for children with special needs. In addition to the technological features of BASIA, support from teachers and parents played an important role during the intervention process. Teachers provided guidance during learning activities, while parents reinforced reading practice outside the classroom. Such collaboration contributed to maintaining children's motivation and ensuring consistent

practice, which are essential factors in phonological development among children with dyslexia.

Implementation of a structured literacy approach in the BASIA application

Research findings indicate that the BASIA application can improve the early reading skills of children with dyslexia through an integrated structured literacy and multisensory learning approach within an adaptive digital system. Improved phoneme accuracy and reading speed indicate that the combination of visual, auditory and kinaesthetic exercises can strengthen children's phonological connections. This aligns with the structured literacy theory proposed by (Rahma et al. 2023), which states that reading instruction for children with dyslexia must be explicit, gradual, and multisensory.

The HURA and SUKA features demonstrate the application of these principles in a digital context. Through HURA, children are introduced to letter sounds separately, while SUKA teaches the combination of sounds into words. This approach aligns with findings (Taupik and Fitriani 2021), which demonstrate that gradual phonetic training can improve the decoding abilities of children with dyslexia. Consistent with research findings (Arbi 2020), systematic implementation of phonological exercises has been shown to significantly improve the early reading skills of children with learning difficulties. However, BASIA presents an innovation with an adaptive system that adjusts the difficulty of the exercises based on the user's error patterns, resulting in a personalised and progressive learning experience. The CERIA feature expands the concept of structured literacy toward meaning-based learning. These findings align with research (Yaacob et al. 2024), which shows that the use of technology-based adaptive literacy media can improve the reading speed and focus of dyslexic students through simultaneous visual and auditory engagement. By presenting simple sentences and story context, children not only read mechanically but also comprehend the content. This approach supports the view (Raffoul and Jaber 2023) that adaptive digital media plays a crucial role in developing contextual literacy in children with special needs. From a psychological perspective, the use of gamification elements such as reading characters and contrasting colours has been shown to increase focus and learning motivation. These results reinforce research (Kholis and Kustiyono 2020), which asserts that interactive media can stimulate intrinsic motivation in children with special needs through a combination of visuals and positive feedback.

Conceptually, this research not only confirms existing theories but also expands the application of structured literacy to Indonesian-language-based technology. This is important because the phonetic structure of Indonesian differs from that of English, which forms the basis of the Orton–Gillingham theory. By adapting local sounds and phonemes, BASIA presents a new model of adaptive literacy learning that is more relevant to the Indonesian context. This research also provides a theoretical contribution in the form of a modification to the Technology-Assisted Structured Literacy (TASL) framework, namely the integration of structured literacy principles with a data-driven adaptive learning system. This model allows teachers and parents to monitor children's development in real time and provide recommendations for further practice tailored to individual needs.

Thus, BASIA functions not only as a learning medium but also as a support system for technology-based inclusive educational interventions. Consistent with the results of a systematic review (Politi-Georgousi and Drigas 2020), most dyslexia apps have proven effective in improving the reading and language skills of children with dyslexia. Overall, the results and discussion of this study demonstrate that BASIA is effective in improving the reading abilities of children with dyslexia while also providing theoretical innovation in the development of adaptive learning media based on structured literacy.

The research results show that the application of structured literacy and multisensory learning within the adaptive digital system of the BASIA application successfully improved the early reading skills of dyslexic children, particularly in terms of phoneme accuracy and reading speed. This finding indicates that the combination of visual, auditory and kinaesthetic exercises presented through the HURA, SUKA and CERIA features can strengthen children's phonological connections. This aligns with the theory of (Rahma et al. 2023), which emphasises that reading instruction for dyslexic children must be explicit, gradual, and multisensory for effective letter and sound decoding.

This finding occurs because BASIA is systematically designed to break down the learning process into three progressive stages: letter sound recognition (HURA), combining sounds into words (SUKA), and understanding meaning in the context of sentences (CERIA). This gradual approach ensures that children are not overwhelmed all at once but learn naturally according to their phonological development. The application's adaptive mechanism also allows for adjustments in difficulty based on user error patterns, ensuring a personalised and progressive learning experience.

These results imply that technology serves not only as an assistive medium but also as an inclusive learning support system that can adapt to each child's needs. With automatic feedback features and gamification elements such as contrasting colours and interactive characters, children with dyslexia experience higher intrinsic motivation. This finding aligns with (Kholis and Kustiyono 2020), who demonstrated that interactive media could improve the focus and learning motivation of children with special needs through positive visual and auditory feedback.

The results of this study are also consistent with those of (Taupik and Fitriani 2021) and (Arbi 2020), who confirmed that gradual phonetic training can improve the decoding abilities of children with dyslexia. However, BASIA offers an innovation by integrating a data-driven adaptive system that monitors user errors to adjust subsequent exercises. This distinction demonstrates BASIA's contribution to the development of more personalised, adaptive technology-based phonological learning models.

Furthermore, the CERIA feature expands the concept of structured literacy into meaning-based learning, where children not only read mechanically but also understand the content of the reading through the context of simple stories. This supports the research findings of (Raffoul and Jaber 2023) and (Yaacob et al. 2024), which confirmed that adaptive digital literacy media can improve focus, reading speed, and comprehension through simultaneous visual and auditory engagement.

Conceptually, this research not only strengthens existing theory but also expands the application of structured literacy to the Indonesian language context, which has a different phonemic structure than English, the basis of the Orton–Gillingham theory. This adaptation makes BASIA relevant to local linguistic needs while contributing to the development of a new model, Technology-Assisted Structured Literacy (TASL), an integration of structured literacy principles and a data-driven adaptive learning system.

Therefore, it can be concluded that the BASIA application functions not only as a reading aid but also as a theoretical and practical innovation in technology-based inclusive literacy interventions. These findings reinforce the findings of (Politi-Georgousi and Drigas 2020), which showed that technology-based applications have been proven effective in improving the reading skills of children with dyslexia. BASIA distinguishes itself with its adaptive and contextual approach, which allows dyslexic children to learn at their own pace and in their own language making it a new model of inclusive literacy learning in Indonesia.

Despite the encouraging findings, several limitations should be acknowledged. First, BASIA currently focuses on phonological reading and does not yet incorporate speech recognition or artificial intelligence features to provide more individualized feedback. Second, the content is limited to early reading stages and simple word decoding. Third, the adaptive mechanism is based on user performance patterns and has not been integrated with broader cognitive profiles. In addition, the study involved a relatively small sample and a short intervention period. Therefore, further validation with larger populations and longer implementation periods is necessary.

Conclusion

The main objective of this research was to develop and evaluate the BASIA (Bantu Baca Disleksia Anak) application as a digital reading aid for children with dyslexia. This study aimed to design an adaptive and inclusive learning tool to support early literacy development among Indonesian elementary school students. The findings indicate that the BASIA application met the criteria of validity, practicality and effectiveness as a learning medium. Validation results from experts and practitioners confirmed that the content, interface, and usability of the application were appropriate for dyslexic learners. Limited classroom trials also showed that BASIA improved students' early reading ability and engagement in literacy activities. In conclusion, BASIA functions not only as a reading-assistive application but also as a pedagogical innovation that integrates structured literacy principles and adaptive technology for inclusive education. This research has several important implications. First, BASIA can serve as a model for teachers, therapists, and educational media developers in designing digital interventions suited to the linguistic characteristics of Bahasa Indonesia. Second, the findings highlight the potential of technology-based literacy support for inclusive classrooms, contributing to policy recommendations on digital inclusion in primary education. However, this study has some limitations. The participant sample was limited to three inclusive elementary schools, and the evaluation focused only on early reading skills within a short intervention period. Future research should involve a larger and more diverse sample, longer implementation periods and the integration of artificial intelligence (AI) to enhance adaptive feedback and analyse students' reading errors more effectively. Future studies are recommended to involve larger and more diverse samples, extend the duration of intervention, and integrate artificial intelligence and speech recognition technologies into BASIA. Further development may also incorporate

teacher–parent monitoring systems and learning analytics to provide more personalised support for children with dyslexia in inclusive educational settings.

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