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Optimizing Digital Literacy Applications for Inclusive Arabic Language Learning for the Visually Impaired

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ABSTRACT

The limited availability of learning media that are accessible and friendly to visually impaired learners remains a significant challenge in Arabic language education. This study aims to optimize inclusive digital literacy through the development of the Arabicara application as a learning medium for visually impaired students. Arabicara is a cloud-based mobile application equipped with key accessibility features, including Text-To-Speech (TTS), a voice-based dictionary, Optical Character Recognition (OCR), audio navigation, and tiered learning materials adapted to users' abilities. By converting printed and digital Arabic text into immediate audio output, the integration of TTS and OCR enables students to study materials and practice vocabulary independently without depending on sighted assistants. This research employed a mixed-methods approach using pretest and posttest instruments, observation, interviews, and documentation to examine the implementation of Arabicara in Arabic language learning. The findings indicate a substantial improvement in learners' vocabulary (*mufrodat*), grammar (*qawa'id*), and listening (*istima'*) skills, with average scores increasing from 22.19 to 57.77 on a 100-point scale. In addition, users demonstrated improved understanding and utilization of key features such as TTS and OCR. These results confirm that Arabicara is effective in enhancing digital literacy and supporting inclusive Arabic language learning for visually impaired students.

1. INTRODUCTION

The rapid advancement of information and communication technology has transformed the way people search, process, and share information. Therefore, digital literacy is a crucial skill for actively participating in today's digitally connected world. Digital technology has also transformed Arabic language instruction through online learning environments such as Google Classroom, Google Forms, and Zoom, which have proven effective in supporting learning interaction and assessment (Prastiwi et al., 2021). Digital literacy is not just about how to use gadgets or computers, but also about using technology wisely, safely, and responsibly. (Putri et al., 2025).

Data from the Central Statistics Agency of Bandung City in 2025 showed that there were 678 people with visual impairments in Bandung City, both those with total blindness and low vision. Based on data from the Coordinating Ministry for Human Development and Culture (Kemenko PMK) from REGSOSEK 2023, the number of people with moderate to severe disabilities in Indonesia reached around 4.3 million people, and most of them are adults and the elderly. They still have difficulty accessing education, health services, and employment (Kemenko PMK, 2025). The 2024 Susenas data also shows that 17.2% of people with disabilities aged 15 years and over have never attended school, while only 4.24% have attended higher education. This condition indicates that many people with disabilities still face significant challenges in being able to live independently, including in accessing education (Aristu & Supriyanto, 2024).

In Islamic schools such as madrasas and Islamic boarding schools, Arabic language lessons play a crucial role because they are used to understand religious texts. However, for blind students, learning Arabic is not easy. The complexity of Arabic orthography, including *harakat*, *makhārij al-ḥurūf*, and *i'rāb*, requires instructional approaches specifically adapted to the characteristics of visually impaired learners. Previous studies have shown that Arabic instruction for blind students demands specialized pedagogical strategies and accessible learning media to ensure equitable learning opportunities (Zulfa, 2020). Access to Arabic language learning for the visually impaired in Indonesia faces various obstacles. Available digital applications contain technical and functional limitations, such as unclear letter pronunciations, *makhārij al-ḥurūf* that fall short of tajwid standards, and incorrect *harakat* readings.

In today's digital era, every individual needs to possess digital intelligence to adapt and respond productively to developments in information technology. Paul Gilster (1997) defines digital intelligence as the ability to understand and process information from various digital media sources. Digital intelligence extends beyond the technical ability to operate devices to include critical thinking skills, media ethics, and collaboration in digital spaces (Manubey et al., 2022). This concept encompasses skills in managing digital media, devices, and networks to search, evaluate, create, and utilize information ethically in daily life (Manubey et al., 2022). It reflects wise thinking in utilizing technology to improve learning quality and requires an awareness of social and moral impacts. Expert consensus from UNESCO emphasizes that digital intelligence enables individuals to utilize technology creatively, collaboratively, and

responsibly (Naufal, 2021). Thus, digital intelligence enriches the learning process and provides broad access to diverse knowledge sources (Sudiantini et al., 2023). In Arabic language education, various digital platforms and online assessment tools have demonstrated their effectiveness in enhancing learner engagement, accessibility, and instructional quality (Al Munawaroh, 2021; Rosyadi & Ilmi, 2021).

Acquiring Arabic as a second language requires understanding meaning and using language in real communication contexts alongside memorizing vocabulary and mastering grammar. Unlike first languages acquired naturally from childhood, second language acquisition demands a systematic learning process shaped by age, environment, and motivation (Annisa et al., 2023). Because Arabic features unique writing systems and linguistic structures, visually impaired learners require specialized instructional media accessible through hearing and touch, such as audio applications and screen reader technology (Rubini & Setyawan, 2020). Successful language acquisition also depends on teacher preparedness, requiring pedagogical and professional competencies to select inclusive strategies (Sofa & Aziz, 2024). In early stages, language learning focuses on spoken vocabulary, whereas advanced instruction emphasizes written language in published texts (Saadataen et al., 2025). Because visually impaired students cannot rely on visual cues like facial expressions or written script, teaching methods must emphasize speaking, listening, and active information exchange (Annisa et al., 2023; Pransiska & Sari, 2022). Integrating interactive methods with Text-To-Speech (TTS) and Optical Character Recognition (OCR) technology automatically converts Arabic text into audio output, creating an inclusive learning environment that builds student communication confidence (Karim et al., 2025).

Learning alters individual behavior through experience and environmental interaction (Huda et al., 2023). Children with visual impairments require specialized instructional channels because their sight does not process daily visual input like sighted peers (Jati & Mahardhika, 2020). Approximate estimates indicate 3.75 million visually impaired individuals in Indonesia, representing 1.5% of the total population, all holding equal rights to education (Jati & Mahardhika, 2020). Because students with disabilities present unique cognitive and sensory needs, general teaching methods fail to serve them effectively (Ambarwati & Harimi, 2021). Inclusive Arabic instruction modifies strategies and media to utilize touch and hearing, employing Arabic Braille, audio recordings for *istima'*, and tactile aids (Wardhani, 2025). An inclusive approach goes beyond technical adjustments; it recognizes the equal right of blind students to learn with empowerment.

Previous studies examined technology applications in special education. First, Tanto & Malau (2022) analyzed digital literacy among visually impaired teachers, finding high proficiency in media creation alongside a need for improved media safety. Second, Susanti et al. (2023) designed smart books combining Braille touch with audio output to help blind children recognize Hijaiyah script. Third, Zain et al. (2024) evaluated MANIQUÍ PARLANTE, an interactive tool allowing blind students to learn Arabic body part vocabulary through direct tactile interaction. Fourth, Walid & Nadaa (2024) examined the Jieshuo screen-reader application for Islamic education, identifying benefits in audio access alongside a shortage of

trained developers. Fifth, research by Biran Asnah et al. (2024) examined screen reader technology and audio-based interactive modules for visually impaired students learning Arabic vocabulary, showing that clear audio feedback improves independent vocabulary acquisition.

Previous studies have successfully integrated various educational technologies into Arabic language learning, including interactive PowerPoint-based learning resources, online learning management systems, and digital assessment platforms. However, these innovations generally target mainstream learners and have not comprehensively addressed the accessibility needs of visually impaired students (Al Munawaroh, 2021; Said & Ulwan, 2023). A synthesis of these previous studies reveals three distinct weaknesses in existing assistive tools for visually impaired learners (Efendi et al., 2023; Haq et al., 2025). First, existing media suffer from a narrow functional focus, addressing only single skills such as basic letter recognition or anatomical vocabulary rather than supporting comprehensive language competence. Second, available tools lack pedagogical integration, separating technology usage from structured digital literacy development. Third, existing digital tools exhibit technical inaccuracies, particularly screen readers and optical recognition systems that fail to correctly process Arabic *harakat*, vowel length, and *makhārij al-ḥurūf*.

To address these limitations, this study presents the development and evaluation of the Arabicara application under the initiative titled "Optimizing Digital Literacy Applications for Inclusive Arabic Language Learning for the Visually Impaired". The Arabicara application directly resolves previous limitations by uniting multi-skill language learning, accurate Text-To-Speech and Optical Character Recognition, and digital literacy development within a single platform. This application offers a concrete solution to open broader, independent, and equal access to learning for visually impaired students, enabling them to continue their development in a technology-based education environment.

2. METHODS

This study operationalized a mixed-methods design by integrating a single-group pretest-posttest quantitative assessment with qualitative field observations, interviews, and documentation (Sugiyono, 2019). The quantitative component evaluated learning effectiveness through pretest and posttest score changes, while the qualitative component tracked user interaction patterns, operational challenges, and participant responses during Arabicara learning sessions. The study involved 21 visually impaired participants (N = 21) selected through purposive sampling at the Sam'an Foundation in Bandung Regency. Participants were aged 15 to 25 years, consisting of 14 individuals with total blindness and 9 with low vision, all having beginner-level (*mubtadi'*) Arabic proficiency.

The data sources in this study consist of two, namely primary data and secondary data. Primary data were obtained directly through observation, interviews, documentation, and diagnostic learning tests at the research location, namely the Sam'an Foundation in Bandung Regency, which houses blind students with a high interest in learning Arabic. The implementation procedure spanned four weeks with eight mentoring sessions, where

participants received structured training on operating Arabicara's core features. Observations were conducted to directly observe the process of using the Arabicara application during learning activities, including interactions between students, accompanying teachers, and the application's features. Interviews were conducted with blind students and accompanying teachers to explore their experiences, responses, and obstacles faced in using the application. Documentation was used to collect data in the form of photos of activities, field notes, and supporting documents related to the implementation of the learning. The test instrument consisted of 15 objective items measuring vocabulary (*mufrodat*), basic grammar (*qawa'id*), and listening (*istima'*). To accommodate visually impaired subjects, tests were administered digitally using screen readers (TalkBack) and direct oral reading for participants requiring physical assistance. Meanwhile, secondary data complemented primary findings through literature searches across books, journal articles, and research reports.

Data analysis integrated both quantitative and qualitative techniques. Quantitative pretest and posttest scores were analyzed using descriptive statistics to evaluate mean score increases and individual learning gains. Qualitative data analysis followed the steps of Miles and Huberman, namely data reduction, data presentation, and concluding. In the data reduction stage, researchers select and focus on data relevant to the research objectives (Asipi et al ., 2022). Next, the data is presented in a systematic narrative format for easy understanding. The final stage is drawing conclusions based on field findings and analysis results, resulting in a comprehensive picture of the Arabicara application's role in supporting Arabic language learning for blind students.

3. RESULTS AND DISCUSSION

The results and discussion section outlines the key findings from the development of the *Arabicara app* as an Arabic language learning tool for the visually impaired. This app helps improve users' Arabic language comprehension and digital literacy skills. Furthermore, *Arabicara* contributes to supporting more inclusive education for the visually impaired.

3.1 Results

The four-week mentoring program yielded measurable quantitative improvements in linguistic performance and feature adoption among the 21 visually impaired participants.

Linguistic Performance and Baseline Analysis

Evaluation of participants' language skills focused on three core areas: vocabulary (*mufrodat*), grammar (*qawa'id*), and listening (*istima'*). Table 1 presents individual pretest and posttest scores across all participants.

Table 1. Comparison of Pretest and Posttest Effectiveness in Terms of Linguistic Understanding

Name	Pretest	Posttest	Improvement
Participant 1	0	40	+40
Participant 2	53.33	60	+4.67
Participant 3	33.33	46.66	+11.33
Participant 4	40	86.66	+46.66
Participant 5	0	33.33	+33.33
Participant 6	20	40	+20
Participant 7	40	66.66	+26.66
Participant 8	60	100	+40
Participant 9	20	33.33	+13.33
Participant 10	13.33	53.33	+40
Participant 11	0	40	+40
Participant 12	0	73.33	+73.33
Participant 13	53.33	80	+26.67
Participant 14	0	73.33	+73.33
Participant 15	0	33.33	+33.33
Participant 16	26.66	86.66	+60
Participant 17	26.66	33.33	+6.67
Participant 18	40	86.66	+46.66
Participant 19	33.33	60	+26.67
Participant 20	0	40	+40
Participant 21	40	46.66	+6.66
Total	465.97	1213.27	+747.3
Average	22.19	57.77	+35.58

The total average score increased from 22.19 on the pretest to 57.77 on the posttest, representing an average gain of 35.58 points on a 100-point scale. Table 1 shows that seven participants (Participant 1, Participant 5, Participant 11, Participant 12, Participant 14, Participant 15, and Participant 20) scored 0.00 on the initial pretest. This zero baseline score resulted from two factors: a complete lack of prior exposure to formal Arabic language instruction and initial unfamiliarity with screen-reader navigation. These students faced dual barriers, possessing zero baseline vocabulary (*mufrodat*) and limited technical confidence in operating assistive software.

Posttest outcomes prove that Arabicara operates effectively for complete beginners. Following four weeks of structured mentoring, participants who started at 0.00 achieved significant score improvements. For instance, Participant 12 and Participant 14 advanced from 0.00 to 73.33, while Participant 1, Participant 11, and Participant 20 reached 40.00. The

application's audio guidance and simplified touch interactions enabled absolute beginners to build foundational language skills independently. These improvements demonstrate the application's inclusive design in accommodating users with no prior linguistic or technological background.

Application Feature Adoption and OCR Harakat Processing

Table 2 and Table 3 detail the shifts in participant operational competence across Arabicara's key accessibility and learning features before and after mentoring. Participant operational competence was evaluated through a practical performance assessment rather than a self-reported questionnaire. Researchers categorized a participant as "Understand" (Competent) if they independently executed specific operational tasks within two minutes without requiring mentor intervention or verbal prompts. Specifically, competency criteria required participants to:

Text-to-Speech (TTS): Adjust speech rate settings and trigger TalkBack to read a sample Arabic sentence correctly. Voice Dictionary: Activate voice input, speak a target word, and retrieve the correct audio translation. Optical Character Recognition (OCR): Align the device camera over a printed Arabic text snippet, capture the image, and initiate accurate audio playback. Graded Material: Navigate to the assigned difficulty tier (*mubtadi'*, *mutawasith*, or *mutaqaddim*) and open the selected lesson. Visually Impaired Navigation: Perform standard TalkBack swipe and double-tap gestures to navigate between main application menus.

Participants who failed to complete these practical tasks independently within two minutes or required physical guidance were categorized as "Do Not Understand Yet" (Non-Competent).

Table 2. Results of the Feature Effectiveness Pretest

Feature	Amount Participant Understand	Amount Participants Do Not Understand Yet	Total Participants	Percentage Understand (%)	Percentage of Not Understanding (%)
Text-To-Speech (TTS)	15	8	23	65.22%	34.78%
Voice Dictionary	20	3	23	86.96%	13.04%
Optical Character Recognition (OCR)	10	13	23	43.48%	56.52%
Graded Material	12	11	23	52.17%	47.83%
Visually Impaired	18	5	23	78.26%	21.74%

Table 3. Posttest Results of Feature Effectiveness

Feature	Amount Participant Understand	Amount Participants Do Not Understand Yet	Total Participants	Percentage Understand (%)	Percentage of Not Understanding (%)
Text-To-Speech (TTS)	21	2	23	91.30%	8.70%
Voice Dictionary	22	1	23	95.65%	4.35%
Optical Character Recognition (OCR)	18	5	23	78.26%	21.74%
Graded Material	20	3	23	86.96%	13.04%
Visually Impaired Navigation	22	1	23	95.65%	4.35%

Posttest results show operational competence gains across all features. The Optical Character Recognition (OCR) feature demonstrated the largest competency rise, moving from 43.48% to 78.26%. Standard Arabic OCR systems frequently struggle to process diacritical marks (*harakat*), as small strokes often merge or disappear during image scanning. Misreading *harakat* alters word meanings and produces incorrect audio pronunciations (*makhārij al-ḥurūf*), creating significant obstacles for visually impaired learners who rely entirely on accurate speech output.

Arabicara resolves this issue through a specialized image pre-processing pipeline tailored for printed Arabic text. The algorithm increases visual contrast to isolate small diacritical strokes prior to character recognition. When diacritical marks remain ambiguous, the system cross-references recognized root letters with a built-in morphological dictionary to supply precise *harakat* vocalizations. This targeted processing engine allowed participant OCR operational competence to increase substantially while ensuring accurate audio output for printed Arabic texts.

Integration with Digital Literacy Theory and Digital Wisdom

Table 2 and Table 3 detail the shifts in participant operational competence across Arabicara's key accessibility and learning features before and after mentoring. The quantitative score gains directly reflect Paul Gilster's digital literacy framework, which defines

digital literacy as the ability to evaluate, process, and apply information across digital platforms rather than mere technical device operation. At the start of the study, participants interacted with assistive technology passively, using basic screen readers without applying them to structured educational tasks.

Through direct engagement with Arabicara, participants transitioned from basic device operation to active information processing. High operational competence in Text-To-Speech (91.30%) and Voice Dictionaries (95.65%) enabled students to verify word definitions, self-correct pronunciation, and navigate instructional materials independently. The overall score jump from 22.19 to 57.77 confirms that participants translated operational tool skills into concrete academic achievement. This progression demonstrates an increase in digital wisdom, as students used digital accessibility features critically to overcome visual learning barriers and master Arabic language concepts independently.

3.2 Discussion

The empirical findings demonstrate that purpose-built assistive technology directly improves educational outcomes and digital independence for visually impaired learners. Analyzing these findings requires examining system architecture, student baseline performance, diacritic recognition mechanics, and digital literacy frameworks.

The Role of Arabicara in Increasing Learning Effectiveness and Optimization

The Arabicara app emerged from a real need for inclusive Arabic language learning media that is accessible to visually impaired students. The app was developed using a cloud-based approach, a mobile application to access it flexibly through various devices without dependence on a single local system. Technically, the Arabicara system is built with a separation between frontend and backend functions. In line with Fikri's opinion (2025), mobile applications function as the main interface where users interact, while cloud services play a role in storing learning materials, learning progress data, and user information. Arabicara's design not only provides freedom for blind users to choose devices according to their needs, but also ensures that learning data is stored securely and can be accessed continuously, so that Arabicara becomes an effective tool that supports the optimization of the Arabic language learning process that is adaptive, modern, and friendly for all groups.

Several key features in the Arabicara app are specifically designed to meet the Arabic language learning needs of blind students. One important feature is *Text to Speech* (TTS), which allows Arabic text and its translation to be read aloud automatically via talkback labels. This feature plays a crucial role in replacing visual functions with auditory ones, allowing students to understand the material independently without relying on sight (Khanam et al., 2022).

Arabicara is also equipped with Optical Character Recognition (OCR) technology, which recognizes Arabic text from images or documents. This technology expands learning resources for blind people by enabling them to access previously inaccessible materials from books and printed materials (Francis & Sangeetha, 2025). Furthermore, voice-based navigation is implemented throughout the application's menus and buttons, allowing blind users to easily navigate features without visual barriers (Sriram, 2025).

Arabicara also provides interactive audio-based exercises tailored to the user's skill level. These exercises include multiple-choice questions, vocabulary introductions, and basic Arabic language comprehension. This feature makes the learning process more active and engaging, and allows users to receive immediate feedback. All learning progress, from

achievement levels to completed material to evaluation results, is stored centrally in a cloud database using Supabase. It uses a systematic *Entity-Relationship Diagram (ERD) design* (Chen, 1975). This system ensures data continuity and facilitates continuous monitoring of student learning progress.

Arabicara's design and interface are developed with high accessibility principles for the visually impaired. Audio navigation is combined with consistent focus order and a minimalist interface to facilitate screen reader use. This approach reflects the principle of digital inclusivity, where every user, both sighted and blind, can access and utilize the application with equal opportunities. With these innovations, Arabicara is not just a supplementary learning medium, but a real solution for optimizing access to Arabic language education for the visually impaired. This application embodies the implementation of inclusive learning oriented towards equality, as well as a digital literacy tool that supports the improvement of Arabic language competency both academically and religiously.

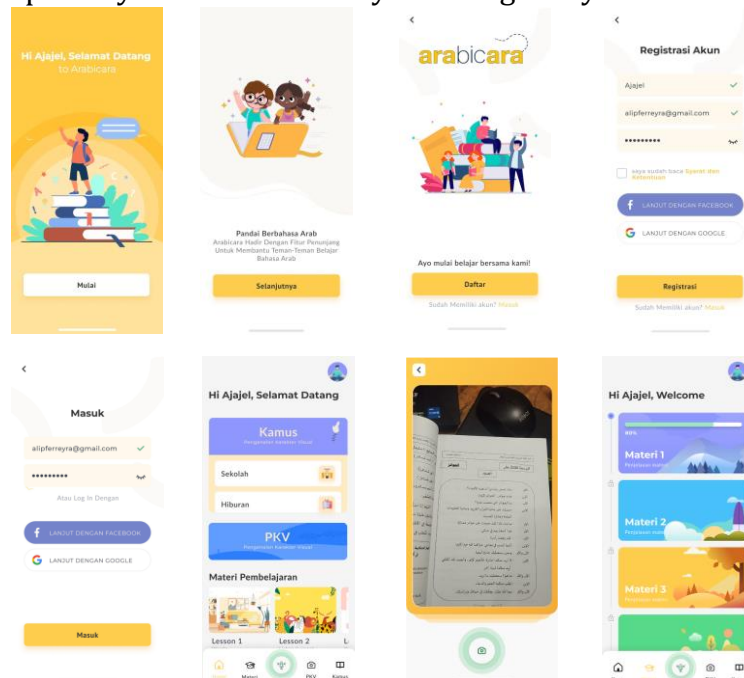


Figure 1. Storyboard Arabicara Application

Analysis of Application Effectiveness Through User Linguistic Understanding Aspects

The effectiveness analysis of this application focuses on the extent to which Arabicara optimizes Arabic language learning for visually impaired participants by improving linguistic comprehension. The Arabicara application is designed as an inclusive digital literacy medium with superior features, such as an Indonesian-Arabic voice dictionary, Optical Character Recognition (OCR) to recognize Arabic text from images, and tiered learning materials that cover *the muftadi'*, *mutawasith*, and *mutaqaddim* levels. In addition, Arabicara also provides audio-based materials that support the mastery of comprehensive Arabic language skills, including *istima'* (listening), *qawa'id* (grammar), and *kalam* (speaking). The application implementation process is carried out through intensive mentoring, so that users can understand the function of each feature and operate it independently with the help of screen reader technology. This approach integrates technical application mastery with linguistic skill development, making the Arabic learning process more effective, adaptive, and inclusive. The following are the comparative results of the pretest and posttest to measure how effective the

Arabicara application is in terms of linguistic understanding:

Table 4. Comparison of Pretest and Posttest Effectiveness in Terms of Linguistic Understanding

Name	Pretest	Posttest	Improvement
Participant 1	0	40	+40
Participant 2	53.33	60	+4.67
Participant 3	33.33	46.66	+11.33
Participant 4	40	86.66	+46.66
Participant 5	0	33.33	+33.33
Participant 6	20	40	+20
Participant 7	40	66.66	+26.66
Participant 8	60	100	+40
Participant 9	20	33.33	+13.33
Participant 10	13.33	53.33	+40
Participant 11	0	40	+40
Participant 12	0	73.33	+73.33
Participant 13	53.33	80	+26.67
Participant 14	0	73.33	+73.33
Participant 15	0	33.33	+33.33
Participant 16	26.66	86.66	+60
Participant 17	26.66	33.33	+6.67
Participant 18	40	86.66	+46.66
Participant 19	33.33	60	+26.67
Participant 20	0	40	+40
Participant 21	40	46.66	+6.66
Total	465.97	1213.27	+747.3
Average	22.19	57.77	+35.58

Based on the results of the posttest and pretest, the Arabicara application is focused on optimizing its use as an inclusive Arabic language learning tool for the visually impaired. Users are introduced to the application's key features, such as an Indonesian-Arabic voice dictionary and an OCR (Optical Character Recognition) feature. Character Recognition to read Arabic text from images, as well as tiered learning materials covering the *mubtadi'*, *mutawasith*, and *mutaqaddim* levels. In addition, users are also trained to utilize audio-based materials that facilitate three key skills: *istima'* (listening), *qawa'id* (grammar), and *kalam* (speaking). Intensive mentoring is provided so that each participant is able to understand and operate the application's features independently with the help of screen reader technology.

The evaluation results conducted through pretest and posttest showed a significant increase in ability. The average score of participants increased from 22.19 in the pretest to 57.77 in the posttest, or an increase of 35.58 points. A Paired Sample t-test confirmed that this score gain was statistically significant ($t(20) = 8.92, p < 0.001$). Furthermore, the calculated Normalized Gain (N-Gain) score reached 0.46, placing the learning effectiveness of the Arabicara application in the medium-gain category. Several participants showed very prominent development, such as Participant 12 and Participant 14 who experienced score gains exceeding 70 points, and Participant 16 who gained 60 points.

To substantiate performance improvements across specific language skills, Table 5 details participant progress divided into vocabulary (*mufrodat*), basic grammar (*qawa'id*),

and listening/pronunciation (*istima'*).

Table 5. Sub-Score Breakdown Across Linguistic Aspects (100-Point Scale)

Linguistic Aspect	Pretest Average	Posttest Average	Score Improvement
Vocabulary (<i>mufrodat</i>)	25.10	62.30	+37.20
Grammar (<i>qawa'id</i>)	18.40	51.20	+32.80
Listening & pronunciation (<i>istima'</i>)	23.07	59.81	+36.74

These results indicate that the use of the Arabicara application contributed to increased vocabulary understanding, improved pronunciation of hijaiyah letters, and gradual mastery of basic Arabic language structures. The *istima'* feature helps users distinguish letter sounds, *qawa'id* strengthens the ability to understand sentence patterns, while kalam provides an opportunity to practice pronunciation according to the correct makhraj.

These findings demonstrate that visual impairment is not an absolute barrier to learning Arabic as long as user-friendly learning media is available and accessible independently. Optimizing Arabicara has been shown to expand access to Arabic language learning for the visually impaired while simultaneously improving their digital literacy skills. With technological support such as voice dictionaries, OCR, and interactive materials, participants can learn more independently and confidently without relying entirely on others for assistance.

Analysis of Application Effectiveness in Terms of Feature Quality

Arabicara app was introduced live, and a pretest was conducted first to assess participants' initial experience using various technology-based features similar to the app's components. These features include Text-To-Speech (TTS), a voice dictionary, and optical zoom. Character recognition (OCR), tiered learning materials, and visually impaired-friendly navigation were also assessed.

The pretest aimed to obtain an initial overview of participants' digital literacy levels and serve as a basis for mapping their actual learning needs. Furthermore, the pretest results served as a benchmark for effectiveness after participants completed the mentoring process. Initial findings indicated varying levels of experience and familiarity with each feature among participants, which then served as the basis for assessing the effectiveness of each feature's use in the Arabicara app. The following data show the percentage of students who understood and those who did not:

Table 6. Results of the Feature Effectiveness Pretest

Feature	Amount Participant Understand	Amount of Participants Who Do Not Understand Yet	Total Participants	Percentage Understand (%)	Percentage of Not Understanding (%)
Text-To-Speech (TTS)	15	8	23	65.22%	34.78%
Voice Dictionary	20	3	23	86.96%	13.04%
Optical	10	13	23	43.48%	56.52%

Character Recognition (OCR)					
Graded Material	12	11	23	52.17%	47.83%
Visually Impaired Navigation	18	5	23	78.26%	21.74%

Based on the results, the *pretest* shows that the feature Text-To-Speech (TTS) is the technology most known by most big participants. Around 65.22% of respondents have used TTS as a tool to help read text through sound, generally by utilizing the *screen reader* on default Android devices. These findings indicate that visually impaired users are quite familiar with audio-based technology as a visual substitute. However, 34.78% of participants still lacked an understanding of how to optimally use TTS, particularly regarding technical settings such as speed and intonation. This indicates a gap in digital literacy that needs to be bridged through further training.

The voice dictionary feature had the highest level of understanding among all features. Nearly all participants (86.96%) reported using or at least understanding how an audio dictionary works. This demonstrates that the primary need for blind users in learning Arabic lies in the ability to access vocabulary quickly and independently. This high level of familiarity underscores the importance of integrating the voice dictionary feature into Arabicara, as it directly addresses their primary barrier: limited access to vocabulary resources without relying on external assistance.

Unlike the previous two features, Optical Character Recognition (OCR) presented a unique challenge. Only 43.48% of participants had experience using this feature, while the remainder had never tried it at all. The main obstacle arose from the complexity of Arabic script, particularly in recognizing harakat and letter lengths, which were often illegible. This finding confirms that developing an OCR specifically for Arabic text remains a critical need and presents significant development opportunities. The low level of user experience with this feature suggests that OCR innovation in Arabicara has the potential to impact the independent learning of blind individuals significantly.

The tiered learning material feature (*mubtadi*, *mutawasith*, and *mutaqaddim*) received a fairly balanced response. Fifty-two (52.17%) of participants understood the concept of tiered learning, while 47.83% were still unfamiliar with the tiering system. Although most participants were familiar with the tiering system through their learning experiences in madrasas or Islamic boarding schools, its application in digital media still requires an adaptation process. Therefore, assistance with the application's use is important so that participants can adjust the material level to their individual abilities, ensuring that learning is progressive and tailored to their individual capacities.

Visually impaired navigation features play a crucial role in the app's successful use. Pretest results showed that 78.26% of participants were familiar with using screen readers like TalkBack to navigate their Android devices, indicating a relatively good level of digital literacy in terms of accessibility. However, 21.74% of participants still experienced difficulties, indicating the need for simpler, more intuitive, and inclusive interface designs to ensure ease of access for all users, including those with limited technological skills.

The pretest results revealed that participants were relatively familiar with the TTS, voice dictionary, and audio-based navigation features, while OCR and graded materials remained key challenges. These findings demonstrate that the Arabicara app serves not only as a new digital innovation but also as a means of improving digital literacy for blind individuals by leveraging familiar technologies while introducing new, previously unavailable features. Thus, the pretest provides an empirical basis for the app's significant potential in bridging the technology access gap and strengthening the linguistic abilities of blind users. Following the mentoring and application process, a posttest was conducted to assess the participants' understanding and ability to utilize Arabicara's key features. Unlike the pretest, which focused on initial experiences, the posttest reflected concrete results following the learning intervention. The results demonstrated significant improvements in participants' digital understanding and skills, confirming the Arabicara app's effectiveness in strengthening digital literacy and supporting the linguistic mastery of blind participants. The following is the latest data from the mentoring and application process:

Table 7. Posttest Results of Feature Effectiveness

Feature	Amount Participant Understand	Amount Participants Do Not Understand Yet	Total Participants	Percentage Understand (%)	Percentage of Not Understanding (%)
Text-To-Speech (TTS)	21	2	23	91.30%	8.70%
Voice Dictionary	22	1	23	95.65%	4.35%
Optical Character Recognition (OCR)	18	5	23	78.26%	21.74%
Graded Material	20	3	23	86.96%	13.04%
Visually Impaired Navigation	22	1	23	95.65%	4.35%

Based on the posttest results, there was a significant increase in understanding of all features in the Arabicara app after participants received assistance. The most notable improvement occurred in the Text-To-Speech (TTS) feature. While in the pretest, only 65.22% of participants were able to use TTS effectively, after training, that figure increased to 91.30%. This indicates that participants are becoming more accustomed to adjusting their voice speed and intonation, enabling the TTS feature to function optimally as a visual substitute in the learning process.

The voice dictionary feature again topped the list in terms of effectiveness. A total of 95.65% of participants were able to use this feature independently after the training. These results confirm that the voice dictionary is the most relevant feature for blind learners, as it provides independent vocabulary access and accelerates Arabic language acquisition, particularly in *reading* and *speaking*.

Quite a striking improvement also appears in the feature Optical Character Recognition (OCR). Before the assistance, only 43.48% of participants understood its use, but after implementing the application, the level of understanding increased to 78.26%. Although there were still 21.74% of participants who experienced technical difficulties, especially in reading the harakat and the length and shortness of Arabic letters, these results prove that the OCR innovation in Arabicara has successfully expanded users' ability to recognize Arabic text independently. This increase of more than 30% demonstrates that the OCR feature has great potential in supporting digital religious literacy for the visually impaired.

The tiered learning material feature also showed significant improvement. A total of 86.96% of participants understood the learning leveling system (*mubtadi*, *mutawasith*, and *mutaqaddim*) after the mentoring process. These results indicate that the Arabicara app successfully helped participants adapt the material to their individual linguistic abilities, resulting in a more systematic, gradual, and progress-oriented learning process.

The visually impaired navigation feature also achieved very positive results, with 95.65% of participants able to navigate the app independently using a screen reader. This achievement demonstrates that Arabicara's interface design meets digital accessibility principles and is compatible with assistive technologies like TalkBack. Only a small proportion of participants still required technical assistance, indicating that the app's interface design is sufficiently inclusive and intuitive for the majority of users.

Overall, posttest results indicated improved comprehension across all key features. The voice dictionary and navigation features demonstrated the highest effectiveness, while the OCR feature demonstrated the greatest improvement. These findings reinforce the evidence that Arabicara serves not only as an Arabic language learning medium but also as an instrument for improving digital literacy for the visually impaired. With its inclusivity-based approach, the app has proven effective in reducing visual access barriers while bridging the gap in technology-based Arabic language learning.

4. CONCLUSION

The development of the Arabicara application has demonstrated success in providing inclusive and user-friendly digital literacy media for the visually impaired. Evaluation metrics demonstrate substantial improvements in linguistic comprehension and tool utilization. Participants achieved an average score increase from 22.19 to 57.77 on a 100-point scale, representing a mean gain of 35.58 points across vocabulary (*mufrodat*), grammar (*qawa'id*), and listening (*istima'*) skills. Operational competence across core features also expanded, led by Optical Character Recognition (OCR) adoption rising from 43.48% to 78.26%, and Text-To-Speech (TTS) reaching 91.30%. These results confirm that visual impairment does not block Arabic language acquisition when supported by adaptive digital media.

This study presents three primary limitations. First, the sample size remains restricted to 21 participants from a single foundation, limiting generalizability across broader populations. Second, the four-week intervention period evaluates short-term feature adoption rather than multi-year language retention. Third, because Arabicara relies on cloud-based database operations, offline usage remains restricted, and OCR scanning occasionally misinterprets diacritics (harakat) when processing low-resolution physical texts.

To advance inclusive education, special education policymakers should integrate accessible mobile applications into the national curriculum for special education schools (SLB) and inclusive madrasas. Future researchers and technology developers should design specialized artificial intelligence algorithms to improve diacritic recognition accuracy for unvoiced Arabic text. Expanding offline storage mechanisms and conducting longitudinal studies across larger regional samples will further strengthen digital accessibility tools for visually impaired students.

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