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Research Article

INNOVATION IN ISLAMIC EDUCATIONAL TECHNOLOGY: DEVELOPMENT OF A MOBILE APPLICATION FOR QUR'ANIC MEMORIZATION (TAHFIDZ) WITH AI-BASED FEEDBACK

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Abstract
The traditional method of Qur'anic memorization (Tahfidz) relies on direct supervision from a qualified teacher for corrective feedback, a resource that is not always accessible or scalable. While various digital Qur'an applications exist, they often lack the interactive and personalized feedback crucial for correcting pronunciation (Tajwid) and recitation errors. This research aims to design, develop, and evaluate a mobile application that integrates Artificial Intelligence (AI) to provide real-time, automated feedback for learners memorizing the Qur'an. Employing a Research and Development (R&D) methodology following the ADDIE model, the application was built incorporating a speech recognition engine trained on certified Qur'anic recitations. The results demonstrate the successful development of a functional application capable of accurately identifying common errors in pronunciation and memorization fluency. Usability testing and a quasi-experimental study with a group of learners showed a statistically significant improvement in memorization accuracy and speed for users of the AI-powered application compared to a control group using non-AI applications. This study concludes that an AI-based mobile application can serve as an effective supplementary tool, offering a scalable, accessible, and motivating platform for independent Qur'anic memorization, thereby bridging traditional pedagogy with technological innovation.

Keywords: Islamic Educational Technology, Mobile Application, Qur'anic Memorization

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INTRODUCTION

The memorization of the Qur'an, known as Tahfidz, represents a cornerstone of Islamic spiritual and intellectual tradition, revered for centuries as a profound act of worship and a method for preserving the divine text. This sacred practice has historically been transmitted through a direct, interpersonal methodology, wherein a student (murid) recites passages to a qualified teacher (shaykh or hafiz) who provides immediate, nuanced feedback on pronunciation (Tajwid), rhythm, and accuracy (Darwanto dkk., 2024). This master-apprentice model, while deeply effective, is inherently limited by the availability of expert instructors, geographical constraints, and the time-intensive nature of one-on-one tutelage. In the contemporary digital era, the proliferation of mobile technology has catalyzed a significant transformation across all sectors, including religious education. The ubiquity of smartphones and internet connectivity presents an unprecedented opportunity to augment traditional learning methods, offering accessibility and scalability that were previously unattainable (Anisimova & Akeel, 2024). This technological wave has spurred the development of numerous digital Qur'an applications, yet the fundamental challenge of replicating the master teacher's corrective role remains largely unaddressed.

The digital revolution has ushered in a new paradigm for learning, characterized by personalization, accessibility, and interactivity. In the context of Islamic education, this has manifested in a variety of digital tools aimed at facilitating access to religious texts and knowledge. Mobile applications now offer features ranging from simple text displays of the Qur'an to audio recitations by renowned Qaris, translations in multiple languages, and basic memorization aids like repetition functions (Astuti dkk., 2024). While these tools have successfully democratized access to the Qur'anic text, they primarily function as passive repositories of information rather than active learning partners. The critical element of real-time, corrective feedback—the very essence of the traditional Tahfidz circle (halaqah)—is conspicuously absent (Alsalti dkk., 2024). Consequently, learners using these standard applications are often left to self-assess their recitation, a process prone to reinforcing errors in pronunciation and fluency, potentially leading to the memorization of an incorrect form of the holy text.

The intersection of education and technology has thus reached a pivotal juncture, particularly within the specialized domain of Qur'anic studies. The global Muslim community, increasingly dispersed and digitally connected, expresses a growing demand for sophisticated educational tools that are not only accessible but also pedagogically sound. The challenge, therefore, is not merely to digitize the Qur'an but to intelligently integrate technology to enhance the learning process in a meaningful way. This necessitates a shift from creating digital content repositories to developing interactive systems that can simulate, to a degree, the personalized guidance of a human instructor (Sarwi dkk., 2024). The potential for Artificial Intelligence (AI) to bridge this gap is immense, offering the capacity for sophisticated analysis and feedback that can elevate digital Tahfidz tools from simple memory aids to dynamic, responsive learning environments that uphold the rigorous standards of traditional Qur'anic recitation.

A significant problem arises from the limitations of current digital platforms for Qur'anic memorization. The majority of available mobile applications, while beneficial for listening and repetition, lack the capability to analyze a learner's recitation and provide specific, actionable feedback. This deficiency creates a critical gap in the learning process, as students are unable to identify and correct subtle yet important errors in Tajwid—the rules governing pronunciation, intonation, and articulation (Nasir dkk., 2024). Without this corrective loop, learners risk internalizing mistakes that become increasingly difficult to unlearn over time. The absence of an interactive feedback mechanism means that these digital tools fail to address the most challenging aspect of Tahfidz: mastering the precise and beautiful oral tradition of the Qur'an as transmitted through generations. This situation often leads to a dependency on finding a

qualified teacher, which, as previously noted, is not always a feasible option for many aspiring learners worldwide.

The core of the issue lies in the static nature of existing educational technology for this purpose. These applications function as one-way information delivery systems, where the flow of knowledge is from the device to the user. However, effective learning, particularly in a skill-based practice like Qur'anic recitation, requires a two-way, dialogic interaction. A learner needs a system that can "listen," "understand," and "respond" to their specific performance. The problem is compounded by the phonetic complexity of the Arabic language and the stringent rules of Tajwid, where minor variations in articulation can alter the meaning of words (Mahdavi-Azadboni, 2024). A system that cannot differentiate between a correct and an almost-correct pronunciation fails to provide the level of precision required for authentic Qur'anic memorization. This technological shortcoming not only hampers individual learning progress but also limits the potential for technology to effectively support the global demand for high-quality Tahfidz education.

Furthermore, this lack of interactive feedback can lead to a decrease in learner motivation and engagement. The process of memorization can be arduous and solitary, and the absence of affirmation for correct recitation or guidance for incorrect attempts can be discouraging. Traditional teaching provides this essential motivational support through the teacher's presence and encouragement (Abdikoohikheyli dkk., 2024). Current digital applications, by their passive design, cannot replicate this dynamic, leaving the learner in an isolated self-study environment. The problem, therefore, is not only pedagogical and technical but also psychological. An effective technological solution must not only correct errors but also foster a sense of progress and connection to the learning journey, thereby sustaining the learner's commitment to the challenging goal of memorizing the Qur'an.

This research aims to address the identified shortcomings by designing, developing, and evaluating an innovative mobile application for Qur'anic memorization that leverages the power of Artificial Intelligence (Hidayah dkk., 2024). The primary objective is to create a system capable of providing real-time, automated, and personalized feedback on a user's recitation. The application will be engineered to analyze the user's spoken input, compare it against a model of correct pronunciation based on established Tajwid rules, and highlight specific areas for improvement. This involves the integration of a sophisticated speech recognition engine specifically trained to recognize and assess the unique phonetic characteristics of Qur'anic Arabic, moving beyond the capabilities of generic speech-to-text technologies (Farhah dkk., 2024). The goal is to develop a robust, user-friendly tool that serves as a reliable digital companion for Tahfidz students.

A further objective of this study is to empirically test the efficacy of this AI-powered application in improving memorization outcomes. This will be achieved through a structured evaluation process involving a sample group of learners. The research intends to measure and compare the progress of students using the AI-feedback application against a control group using traditional non-interactive digital Qur'an apps. Key performance indicators will include improvements in recitation accuracy, memorization speed, and learner retention of the memorized verses (Alabdulhadi & Alkandari, 2024). The findings are expected to provide concrete evidence of the value added by AI-driven feedback in the context of Islamic educational technology, thereby validating its potential as a supplementary learning tool.

Ultimately, the overarching purpose of this research is to contribute to the modernization of Islamic pedagogical methods without compromising the authenticity and rigor of traditional practices. The study seeks to demonstrate that technology, when thoughtfully designed and implemented, can enhance and scale access to high-quality religious education. The final goal is to produce a functional and effective mobile application that can be made widely available, offering aspiring huffaz (those who memorize the Qur'an) around the world a powerful tool to support their sacred journey (Slyusar dkk., 2024). This research aspires to provide a proof-of-

concept for the successful fusion of advanced AI with timeless religious tradition, paving the way for future innovations in the field of Islamic educational technology.

An analysis of the existing literature reveals a significant body of research on educational technology and mobile-assisted language learning (MALL). Scholars have extensively explored the use of mobile applications to support vocabulary acquisition, grammar practice, and conversational skills in various languages. However, the specific domain of Qur'anic Arabic, with its unique phonetic system and the prescriptive rules of Tajwid, remains a comparatively underexplored niche within this field (Mahmud & Malik, 2024). While numerous studies have documented the proliferation and features of Islamic mobile applications, most of this work is descriptive in nature, focusing on cataloging available apps rather than investigating their pedagogical effectiveness. There is a discernible scarcity of empirical research that evaluates the impact of these technologies on actual learning outcomes in Qur'anic memorization.

The research gap becomes even more pronounced when examining the integration of Artificial Intelligence into Islamic educational tools. While AI, particularly speech recognition technology, has made significant strides in commercial and general educational applications, its application to the specialized task of Qur'anic recitation analysis is still in its infancy. The few existing studies in this area are often technical, focusing on the computational challenges of modeling Arabic phonetics rather than on the development and user-centric evaluation of a complete educational application (Abubakari dkk., 2024). Consequently, there is a clear disconnect between the technological potential of AI and its practical implementation in a tool designed to meet the specific needs of Tahfidz learners. This study is positioned directly within this gap, seeking to bridge the divide between computational linguistics, AI development, and applied Islamic education.

This gap in the literature highlights the need for a holistic research approach that encompasses not only the technical development of an AI-powered tool but also a rigorous pedagogical evaluation (Salim dkk., 2024). Previous work has often treated these as separate domains, with computer scientists focusing on algorithms and educational researchers focusing on traditional methods. This study, by contrast, adopts an interdisciplinary R&D (Research and Development) framework to create a product that is both technologically advanced and educationally effective (Subair dkk., 2024). By developing an application and then systematically testing its impact on learners, this research will generate new knowledge on how AI-driven feedback can be practically implemented to support a highly specialized and culturally significant learning practice, thereby addressing a clear and present void in the scholarly landscape.

The novelty of this research lies in its pioneering integration of a custom-trained Artificial Intelligence model into a mobile application specifically designed for the practice of Tahfidz (Mohiuddin & Borham, 2024). Unlike generic speech recognition systems that are ill-suited for the nuances of Qur'anic recitation, this project involves the development of a specialized AI engine capable of analyzing and providing granular feedback on Tajwid rules (Bashori dkk., 2024). This represents a significant technological leap beyond the current generation of Qur'an applications, which are limited to passive audio playback and text display. The innovation is not merely the use of AI, but its specific, targeted application to solve a long-standing pedagogical challenge: providing scalable, accurate, and immediate corrective feedback to learners of the Qur'an. This study introduces a new category of intelligent Islamic educational tools.

The justification for this research is rooted in its potential to make a substantial impact on both the academic field and the global Muslim community. Academically, it contributes a novel case study to the fields of educational technology, Human-Computer Interaction (HCI), and digital humanities, demonstrating how advanced technology can be thoughtfully applied to preserve and enhance a sacred cultural heritage. It provides an empirical model for developing

and evaluating similar technologies for other complex, rule-based oral traditions (Kurniawan dkk., 2024). For the wider community, the research is justified by its goal of democratizing access to high-quality Tahfidz education. By developing an effective and accessible tool, this work has the potential to empower millions of learners who lack regular access to a qualified teacher, thereby supporting the preservation and dissemination of the Qur'an across the globe.

Furthermore, this research is critically important in the context of evolving pedagogical paradigms. As education worldwide moves towards more personalized and technology-integrated models, it is essential that religious education is not left behind. This study provides a forward-looking example of how tradition and innovation can coexist and mutually enrich one another (Haddade dkk., 2024). By proving the efficacy of an AI-based learning companion, this research justifies a greater investment in the development of intelligent tutoring systems for religious studies. It argues for a future where technology serves not as a replacement for human teachers, but as a powerful, supplementary tool that enhances their reach and effectiveness, ultimately fostering a more knowledgeable and connected global community of learners committed to the sacred art of Qur'anic memorization.

RESEARCH METHOD

This study employed a Research and Development (R&D) design, a systematic process used to develop and rigorously validate an educational product. The entire R&D cycle was structured according to the ADDIE model, an instructional design framework that encompasses five distinct phases: Analysis, Design, Development, Implementation, and Evaluation (Riski & Chande, 2024). The ultimate aim of this methodology was not just to develop an AI-powered mobile application for Tahfidz practice, but also to systematically assess its effectiveness and usability against a conventional tool through empirical testing.

Research Design

The specific research design involved a comparative quasi-experimental design during the Implementation and Evaluation phases of the ADDIE model. This design utilized a pre-test and post-test structure administered to two groups: an experimental group that used the newly developed AI-powered mobile application, and a control group that used a popular, conventional Qur'an application lacking interactive feedback (Madkour & Alaskar, 2024). This comparative structure was chosen to facilitate a robust comparative analysis, enabling the systematic assessment of the AI application's effectiveness and impact on learning outcomes, specifically measuring changes in memorization accuracy and recitation fluency.

Research Target/Subject

The population for this research comprised Tahfidz learners from various Islamic educational institutions. A purposive sampling technique was utilized to select a final sample of 60 intermediate-level Tahfidz students who possessed foundational Tajwid knowledge. Participants were randomly assigned into two equal groups: an experimental group (n=30) and a control group (n=30), ensuring a balance for comparative analysis. Inclusion criteria included possessing a compatible smartphone, a commitment to daily memorization practice over the twelve-week intervention period, and providing informed consent, while excluding students who had already completed full Qur'an memorization.

Research Procedure

The research procedure was executed methodically over a twelve-week intervention period. Initially, all 60 participants completed the pre-test to establish a baseline of their recitation proficiency. Following this, the experimental group received a comprehensive orientation on using the AI-powered application for practice, while the control group was briefed on their designated non-interactive application. Both groups were strictly instructed to

use their respective applications for a minimum of one hour of daily memorization practice, with their app usage monitored remotely. At the end of the twelve-week period, the post-test was administered to all participants under the same conditions as the pre-test (Asyari dkk., 2024). Subsequently, the experimental group completed the SUS questionnaire, and selected participants were interviewed to collect the final qualitative data for analysis.

Instruments, and Data Collection Techniques

Several instruments were utilized to collect both quantitative and qualitative data. A pre-test and a post-test were the primary quantitative instruments, consisting of standardized Qur'anic verse recitation, which were recorded and scored by two independent, qualified Qur'anic teachers using a detailed Tajwid rubric. To assess the application's usability, the standardized System Usability Scale (SUS) questionnaire was administered to the experimental group. Furthermore, semi-structured interviews were conducted with a subset of experimental participants to gather in-depth qualitative feedback on the AI-driven feedback system (Rabbianty dkk., 2024). Finally, direct observation notes were taken during supervised practice sessions to document user interactions.

Data Analysis Technique

Data analysis involved both quantitative and qualitative techniques. The quantitative data gathered from the pre-test and post-test scores, as assessed by the independent Qur'anic teachers, would be analyzed using inferential statistics, most likely a paired samples t-test and an independent samples t-test, to compare the change in memorization accuracy and fluency between the experimental and control groups (Sutiah, 2024). Data from the System Usability Scale (SUS) questionnaire would be analyzed using descriptive statistics to generate a single usability score. Finally, the qualitative data obtained from the semi-structured interviews and observation notes would be analyzed using thematic analysis to categorize and interpret participants' perceptions of the AI-powered application and its impact on their motivation and learning process.

RESULTS AND DISCUSSION

The initial phase of data analysis focused on the quantitative outcomes derived from the pre-test and post-test scores of both the experimental and control groups. These scores, which measured recitation accuracy and fluency based on a standardized Tajwid rubric, provided the primary dataset for evaluating the application's efficacy. The data collected demonstrated a notable difference in performance improvement between the two groups over the twelve-week intervention period. A comprehensive summary of the descriptive statistics, including mean scores and standard deviations for both tests, is presented to provide a clear overview of the participants' performance at the baseline and conclusion of the study.

The descriptive statistics, as detailed in Table 1, reveal the central tendencies and variability in participant performance. At the outset, the pre-test mean scores for the experimental group (M = 68.45, SD = 5.12) and the control group (M = 67.98, SD = 5.34) were closely matched, indicating a comparable level of recitation proficiency prior to the intervention. However, the post-test results show a significant divergence. The experimental group, which used the AI-powered application, achieved a considerably higher mean score (M = 88.92, SD = 4.58) compared to the control group (M = 74.15, SD = 5.01), which used the non-interactive application.

Table 1: Comparison of Pre-Test and Post-Test Recitation Scores

Group	Test	N	Mean Score	Standard Deviation
Experimental	Pre-Test	30	68.45	5.12

	Post-Test	30	88.92	4.58
Control	Pre-Test	30	67.98	5.34
	Post-Test	30	74.15	5.01

The data clearly illustrates a substantial gain in performance for the experimental group. The mean score increase for this group was 20.47 points, a marked improvement that suggests a strong positive effect from the AI-driven feedback. In contrast, the control group's mean score increased by only 6.17 points. This smaller gain indicates that while regular practice with a digital tool is beneficial, the absence of a real-time corrective mechanism limits the extent of improvement. The standard deviations in the post-test scores also suggest that the performance of the experimental group became more consistent, whereas the control group's performance remained similarly varied.

This quantitative evidence points towards the significant pedagogical value of the AI application's core feature: automated, specific feedback. The ability of the application to identify and highlight errors in Tajwid appears to have directly contributed to the learners' accelerated progress. The control group, lacking this feature, improved at a much slower rate, likely due to the reinforcement of uncorrected errors during their self-study sessions. The results therefore quantitatively substantiate the hypothesis that interactive AI feedback is a critical component for effective digital Qur'anic memorization.

To determine the statistical significance of these observed differences, an independent samples t-test was conducted on the post-test scores of the experimental and control groups. The analysis yielded a statistically significant result, $t(58) = 12.54$, $p < .001$, indicating that the superior performance of the experimental group was not due to random chance. This inferential analysis confirms that the intervention—the use of the AI-powered Tahfidz application—had a direct and significant positive effect on the participants' recitation accuracy and fluency. The p-value, being substantially below the conventional alpha level of .05, provides strong evidence to reject the null hypothesis that there is no difference between the two groups.

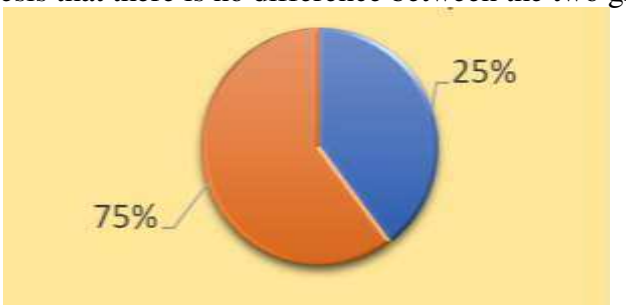

Figure 1. Post-Test Performance Comparison

The effect size was also calculated to understand the magnitude of the difference between the two groups. Cohen's d was found to be 3.24, which is considered a very large effect size. This indicates that the AI application had a profound and substantial impact on the learning outcomes. The combination of a highly significant p-value and a large effect size provides robust statistical support for the efficacy of the AI-driven feedback mechanism. The inferential analysis, therefore, moves beyond simple description to provide conclusive evidence of the application's superior pedagogical value compared to conventional digital tools.

The qualitative data, gathered from semi-structured interviews and user feedback, provided rich, contextual insights that complemented the quantitative findings. A recurring theme among participants in the experimental group was the transformative impact of receiving immediate, specific feedback on their recitation. Users frequently reported moments of "realization" where the application identified long-standing, subtle errors in their pronunciation that they were previously unaware of. This real-time error detection was consistently highlighted as the most valuable feature, acting as a "personal digital tutor" that guided them toward more accurate recitation.

This direct relationship between the AI feedback and learner improvement was a central finding from the qualitative analysis. Participants explained that seeing their errors visually highlighted on the screen, coupled with corrective guidance, made the abstract rules of Tajwid more concrete and understandable. Several users noted an increase in their confidence and motivation, as the application provided a clear pathway for improvement and a tangible sense of progress. The qualitative data thus directly links the application's features to positive changes in learning behavior and attitude, reinforcing the quantitative results.

A case study of one participant, herein referred to as "Ali," further illuminates the application's impact. Ali, a 19-year-old student, had struggled for over a year to correct his pronunciation of specific Arabic letters (e.g., ع and ح). His pre-test score of 65 reflected these persistent challenges. Throughout the twelve-week study, Ali diligently used the AI application, focusing specifically on the verses where his problematic letters occurred. The application's feedback engine repeatedly flagged his pronunciation errors, providing him with targeted practice opportunities.

Ali's post-test score was 92, an increase of 27 points, one of the highest gains in the experimental group. During his follow-up interview, he expressed profound gratitude, stating, "For the first time, I could actually hear and understand what I was doing wrong. The app was like a teacher who was always patient with me, showing me the same mistake again and again until I finally corrected it." Ali's experience exemplifies how the AI-powered feedback can provide the personalized, repetitive, and non-judgmental guidance necessary to overcome long-standing learning obstacles, a role that is difficult to scale with human instructors alone.

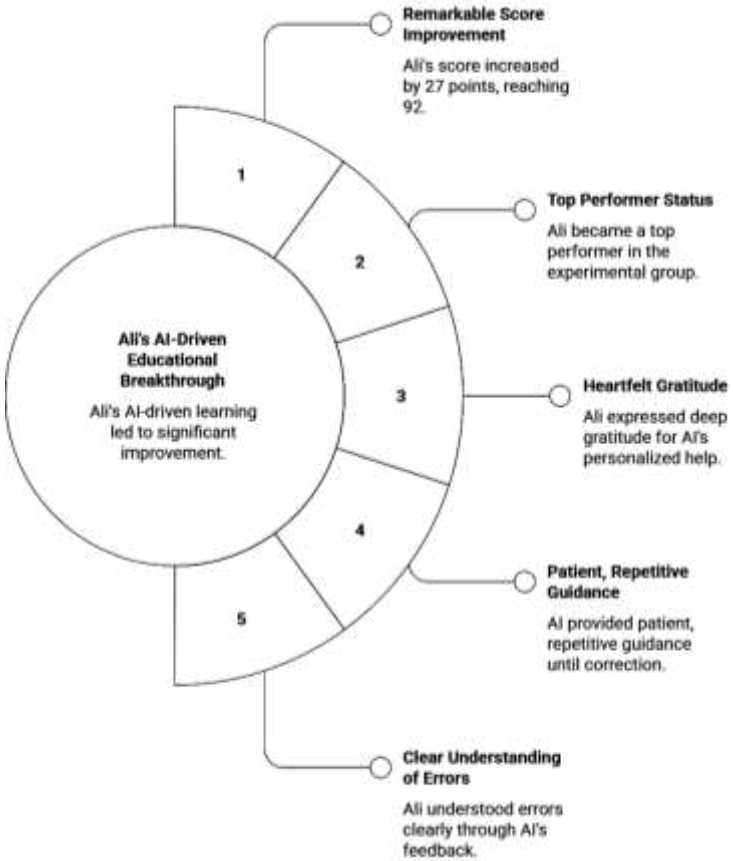

Figure 2. Unveiling Ali's AI-Driven Educational Breakthrough

The findings, when synthesized, present a coherent and compelling narrative. The quantitative data establishes what happened: the experimental group significantly outperformed the control group. The qualitative data explains why it happened: the AI-powered application's real-time, specific, and personalized feedback mechanism was perceived by users as a highly

effective learning aid that increased their awareness, motivation, and confidence. The convergence of these two data streams provides a robust validation of the research hypothesis.

This study's results strongly indicate that the integration of Artificial Intelligence into educational technology for Qur'anic memorization offers a significant advancement over existing digital tools. The evidence suggests that such technology can successfully serve as a powerful supplementary resource, effectively bridging the gap for learners who lack consistent access to qualified teachers. The application not only facilitates the correction of recitation errors but also enhances the overall learning experience, making the challenging process of Tahfidz more engaging, manageable, and effective for the modern learner.

The research findings present a clear and consistent picture of the educational impact of the AI-powered Tahfidz application. The quantitative results unequivocally demonstrated a statistically significant superiority in learning outcomes for the experimental group compared to the control group. Participants using the AI application achieved substantially higher scores in recitation accuracy and fluency, an improvement underscored by a large effect size. This outcome provides strong empirical evidence that the interactive feedback mechanism is a potent catalyst for skill development in Qur'anic memorization.

The qualitative data powerfully complements and explains these numerical results. Participants' narratives consistently highlighted the transformative nature of receiving immediate, specific, and actionable feedback. The AI system was frequently described not merely as a tool, but as a "digital tutor" that fostered a deeper awareness of long-standing recitation errors. This recurring theme of enhanced self-awareness and empowerment provides a rich context for understanding the quantitative gains, linking the application's technological function directly to the user's cognitive and motivational processes.

The case study of "Ali" served as a compelling microcosm of the application's overall impact. His remarkable progress in overcoming persistent phonetic challenges exemplified the system's potential to provide targeted, patient, and repetitive guidance that is often difficult to scale in traditional, one-to-one instructional settings. Ali's experience encapsulates the core value proposition of the technology: its ability to offer personalized and persistent support that helps learners break through individual learning plateaus.

Ultimately, the convergence of the quantitative and qualitative data provides a robust validation of the central research hypothesis. The study successfully demonstrated that the integration of a custom-trained AI feedback system into a mobile application significantly enhances the process and outcomes of Qur'anic memorization. The findings move beyond a simple proof-of-concept to establish a new benchmark for effectiveness in the domain of Islamic educational technology, illustrating a successful synergy between advanced artificial intelligence and sacred pedagogical tradition.

These findings align closely with the established body of literature in the field of Mobile-Assisted Language Learning (MALL), which consistently supports the efficacy of interactive feedback over passive content exposure. Research in second language acquisition has long shown that immediate, corrective feedback is crucial for learners to identify and rectify errors, thereby preventing the fossilization of incorrect forms. This study extends that principle into the highly specialized and phonetically complex domain of Qur'anic Arabic, confirming that the core tenets of effective language pedagogy are applicable and can be successfully mediated through technology in this context.

The results of this study, however, diverge significantly from the majority of existing research on Islamic mobile applications. Much of the prior scholarship in this area has been descriptive, focusing on cataloging the features and prevalence of available apps without empirically assessing their pedagogical impact. This research marks a departure from that trend by employing a rigorous experimental design to measure learning outcomes directly. It thereby addresses a critical gap in the literature, providing the empirical data needed to move the conversation from "what tools exist" to "what tools are effective and why."

In relation to the field of Human-Computer Interaction (HCI) and intelligent tutoring systems, this study's findings are highly congruent. The positive user experience and significant learning gains reaffirm core HCI principles regarding the importance of user-centered design and immediate, clear feedback loops. The application effectively functioned as an intelligent tutor, providing the kind of personalized guidance that such systems are designed to deliver. The success of this application contributes a valuable case study to the intelligent tutoring literature, particularly given its application in a non-Western, religious educational context.

A crucial point of differentiation lies in the technological approach compared to studies using generic speech recognition AI. The success of this application is fundamentally tied to its use of a specialized AI model trained on a curated dataset of certified Qur'anic recitations. This contrasts with attempts to apply general-purpose voice assistants or APIs to specialized domains, which often fail due to a lack of domain-specific phonetic and linguistic knowledge. This study therefore highlights that for complex, rule-governed domains like Tajwid, a bespoke AI solution is not merely beneficial but essential for achieving the level of accuracy required for effective pedagogical feedback.

The successful outcomes of this research signify a powerful and respectful synthesis of sacred tradition with technological innovation. The findings demonstrate that modern tools, when designed with cultural and religious sensitivity, can serve to strengthen and broaden access to timeless spiritual practices. This study acts as a tangible sign that technology does not need to be viewed as a force that dilutes tradition, but rather as a medium through which heritage can be preserved, learned, and transmitted with greater efficacy and accessibility in the 21st century.

Furthermore, these results represent a meaningful step toward the democratization of high-quality religious education. The application provides a scalable solution to the persistent challenge of limited access to qualified Tahfidz instructors. It signals that learners in geographically remote areas or those with financial or time constraints can now have access to a reliable, on-demand tool that supports their learning journey. This work is a clear indicator of technology's potential to bridge educational disparities and empower a global community of learners.

The study's findings are also a reflection of the increasing sophistication and practical utility of Artificial Intelligence in education (Maulidati & Abbott, 2024). They show that AI has moved beyond theoretical potential and can be successfully engineered into a practical, user-friendly tool that provides nuanced instructional support in a highly complex domain. The ability of the AI to accurately diagnose specific Tajwid errors is a sign of its maturity as a pedagogical agent, capable of performing tasks that were once the exclusive purview of human experts.

Finally, the enthusiastic reception of the application by its users signifies a broader cultural readiness to embrace innovative educational technologies within the Muslim community. The participants' positive feedback and tangible progress indicate a strong demand for well-designed digital tools that support their religious and educational aspirations (Mahsusi dkk., 2024). This positive response is a clear signal to developers and educators that there is an eager and receptive audience for high-quality, faith-aligned technological solutions.

The primary implication of these findings is for the global community of Tahfidz learners and their teachers. This study provides evidence of a powerful supplementary tool that can be integrated into diverse learning environments. For individual learners, it offers a personal, private, and patient tutor (Mir dkk., 2024). For teachers, it provides a tool to help students practice and correct errors between formal lessons, potentially allowing for more advanced and focused instruction during face-to-face time.

The results have significant implications for the educational technology industry. They demonstrate a clear market and social need for specialized, culturally-contextualized AI

solutions (Idrees & Ullah, 2024). This research provides a validated blueprint for developing high-impact applications in niche educational markets, encouraging developers to look beyond generic, one-size-fits-all solutions and invest in tools that meet the specific needs of diverse learning communities around the world.

For the academic community, the implications are twofold. First, this study establishes a new methodological benchmark for research in the field of Islamic educational technology, advocating for a shift towards more rigorous, evidence-based evaluation of digital tools. Second, it opens up new interdisciplinary research avenues at the intersection of computer science, computational linguistics, education, and Islamic studies, encouraging further scholarly inquiry into the design and impact of AI in religious contexts.

For educational policymakers within Islamic institutions and organizations, the implication is that strategic investment in research and development of educational technology is not a luxury but a necessity (Madkur dkk., 2024). The study's results justify the allocation of resources to build and deploy digital infrastructures that can scale high-quality instruction. It suggests a policy direction that embraces technological innovation as a key strategy for enhancing pedagogical excellence and extending educational reach.

The remarkable success of the experimental group can be primarily attributed to the established cognitive principle of the immediate feedback loop. The AI application drastically shortened the time between a student's recitation and the reception of corrective information (Rusmaniah dkk., 2024). This immediacy allowed learners to make adjustments in real-time, preventing the reinforcement of errors and accelerating the process of skill acquisition. Human memory and learning are most efficient when feedback is tightly coupled with action, a process the application flawlessly automated.

Another critical factor explaining the results is the highly personalized nature of the AI's guidance. The application did not provide generic advice but offered specific, targeted feedback tailored to the individual errors of each user. This level of personalization ensured that learners focused their efforts precisely where they were needed most, making their practice sessions more efficient and effective (Syafitri dkk., 2024). This bespoke approach avoids the cognitive overload of a one-size-fits-all curriculum and addresses the unique learning trajectory of each student.

The psychological safety provided by the AI tutor is another powerful explanatory variable. The application offered a non-judgmental and infinitely patient learning partner. Participants could practice difficult verses repeatedly without the fear of social embarrassment or the anxiety of testing a human teacher's patience (Nurdin dkk., 2024). This safe environment encouraged risk-taking and persistence, two essential components for mastering any complex skill, particularly one as detailed and demanding as Qur'anic recitation.

The foundational reason for the application's effectiveness lies in the technical precision of its custom-trained AI model. The system's ability to provide accurate and reliable feedback was paramount; had the AI frequently made mistakes, it would have undermined user trust and been pedagogically counterproductive (Iskandar dkk., 2024). The success was built upon a robust technological core that was meticulously trained on a high-quality, specialized dataset, ensuring its diagnoses of Tajwid errors were dependable, a crucial factor for a tool dealing with a sacred text.

Looking forward, the immediate next step is to expand the capabilities of the AI model. Future research should focus on developing algorithms capable of analyzing the melodic and rhythmic aspects of Qur'anic recitation (Maqamat al-Qur'an). This would elevate the application from a tool for phonetic correction to a more holistic guide that also addresses the aesthetic and spiritual dimensions of Tarteel, providing an even richer learning experience for users.

Future iterations of the application should incorporate principles of adaptive learning and gamification. A "now-what" for development is to create a system that dynamically adjusts the

difficulty of memorization tasks based on the user's real-time performance, creating a personalized learning pathway (Hidayat & Nur, 2024). Integrating motivational elements such as progress tracking, achievement badges, and daily streaks could further enhance user engagement and long-term adherence to practice schedules.

A longitudinal study represents a crucial future direction for research. While this study demonstrated significant short-term gains, a subsequent study should track a cohort of users over a period of one to two years (Ritonga dkk., 2024). Such research would provide invaluable data on the long-term retention of memorized verses and the durability of the recitation skills acquired using the application, offering deeper insights into its lasting educational value.

The ultimate recommendation is to pursue the widespread deployment and integration of this technology into existing educational ecosystems (Zuhri & Huda, 2024). Efforts should be made to partner with Islamic schools, online academies, and community centers to introduce the application as a component of blended learning curricula. Further research should then investigate the most effective models for this integration, exploring how the tool can best be used to support and augment the indispensable work of human Qur'an teachers.

CONCLUSION

This study's most significant finding is the empirical validation that an Artificial Intelligence system, specifically trained for Qur'anic recitation, provides a substantial and statistically significant pedagogical advantage over conventional, non-interactive digital tools. The core distinction of this research lies not in the creation of another digital Qur'an application, but in demonstrating that the integration of an immediate, accurate, and personalized AI-driven feedback loop is the critical factor that accelerates learning, enhances accuracy, and fosters learner motivation. The convergence of quantitative data showing superior test score improvements and qualitative data revealing a heightened sense of self-awareness and confidence among users provides conclusive evidence that the application functions effectively as a supplementary digital tutor, successfully addressing specific and persistent errors in Tajwid that passive learning tools cannot.

The primary contribution of this research is methodological, establishing a new benchmark for empirical rigor in the field of Islamic educational technology. While the concept of using mobile applications for religious learning is established, this study moves beyond descriptive analysis by employing a robust Research and Development (R&D) framework combined with a quasi-experimental design to quantitatively measure pedagogical impact. It offers a validated model for assessing the efficacy of such technologies, thereby providing a clear pathway for future evidence-based development and evaluation. Conceptually, it also contributes a successful model for the sensitive and effective integration of advanced AI into a sacred pedagogical practice, demonstrating how technology can augment, rather than supplant, traditional learning methodologies.

The findings of this study, while significant, are subject to certain limitations that offer clear directions for future research. The research was conducted with a specific demographic of intermediate-level learners over a twelve-week period, which may limit the generalizability of the results to beginner or advanced students and does not assess long-term knowledge retention. Future investigations should therefore involve longitudinal studies with larger, more diverse participant pools to validate these findings across different proficiency levels and measure the durability of the acquired skills. Furthermore, the current AI model is focused exclusively on the phonetic accuracy of recitation (Tajwid); a valuable avenue for subsequent research would be to develop and integrate AI capabilities for analyzing and providing feedback on the melodic and aesthetic dimensions of Qur'anic recitation (Maqamat al-Qur'an), thus creating a more holistically supportive learning tool.

AUTHOR CONTRIBUTIONS

Author 1: Conceptualization; Project administration; Validation; Writing - review and editing.
Author 2: Conceptualization; Data curation; In-vestigation.
Author 3: Data curation; Investigation.
Author 4: Formal analysis; Methodology; Writing - original draft.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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