Journal of Islamic Technology (JITech)
Jurnal Teknologi Islam (JITech)

Exploring Hijaiyyah Letter Recognition Through Teachable Machine

Dk Norhazatulimah Pg Haji Abdul Salam
PhD Research Student
Faculty of Islamic Technology, UNISSA

Dayang Hajah Tiawa binti Awang Haji Hamid
Assistant Professor
Faculty of Islamic Technology, UNISSA

Dr. Haji Ahmad Baha Haji Mokhtar
Assistant Professor
Faculty of Usuluddin, UNISSA

Professor Dr. Haji Abdul Hafidz bin Haji Omar
Professor
Faculty of Islamic Technology, UNISSA

Vol. 1, Issue 1 | 2025

KEYWORDS

Hijaiyyah Letters, Quran pronunciation, Teachable Machine

ABSTRACT

Proper articulation of Hijaiyyah letters is important for Quranic recitation because precise pronunciation determines the meaning and maintains Tajweed compliance. This study investigates how Teachable Machine by Google enables the recognition of Hijaiyyah letter pronunciation using real-time voice input. The researcher's voice provided data for training the model which was then evaluated using input from two different participants. The researcher recorded prediction confidence percentages for every letter and evaluated model performance through average score calculations. The letters classified into high, moderate, or low accuracy categories based on their calculated mean values. The study results show that Teachable Machine achieves reliable recognition of multiple letters especially when the letters have distinct phonetic features and clearer pronunciation. The model delivered valuable real-time feedback to learners even when certain letters presented challenges because of their similar pronunciations or softer sounds. Accessible AI tools demonstrate potential for foundational Quranic pronunciation instruction for independent learners and teacher-supplemented guidance through this exploratory study. Our findings establish a baseline for developing advanced AI-based educational tools for learning the Quran.

Introduction

The accurate articulation of the Hijaiyyah letters which make up the total of 29 Arabic alphabet characters serves as the basic foundation of Quranic recitation which also an important element of Tajweed. Proper pronunciation of Quranic verses requires each letter to be articulated at its specific makhraj (articulation points) and sifat (characteristics) to preserve both meaning and integrity. Slight pronunciation errors can change meanings and lead to the invalidation of

essential religious practices like Salah (prayer) (Ibrahim, Yusoff, & Razak, n.d.). Recognizing and articulating Hijaiyyah letters accurately represents a spiritual necessity beyond just a linguistic proficiency.

The traditional practice of Tajweed instruction has always depended on face-to-face teaching methods between teacher and student. The traditional teaching approach requires students to memorize information through repeated practice while receiving feedback from an experienced teacher. The strategy used by the teacher proves effective yet demands substantial resources and depends on skilled instructor availability along with learner access and time commitment. Many regions, particularly where Arabic is not the primary language experience difficulties in getting access to reliable Tajweed teaching (Rosni & Halim, 2020).

As digital education growing and the increasing accessibility to Artificial Intelligence (AI) technologies, people are showing more interest in using these advancements to aid Quranic education. Digital platforms and mobile applications enable learners to practice their pronunciation while identifying mistakes and understanding Tajweed rules better. These educational tools supplement traditional methods by providing flexible and personalized learning experiences that are accessible at any time (Afzal et al., 2023). Recent pedagogical models especially pertaining to blended or distance learning frameworks support the integration of digital tools in religious education (Zulkefli & Ismail, 2019). Educational institutions are increasingly adopting no-code machine learning platforms that enable educators and students to create basic AI models without needing to learn programming skills. Google developed Teachable Machine as an educational tool for creating machine learning models. Teachable Machine was developed for classroom experiments to offer a user-friendly interface that enables the creation of models for classifying audio, image, and pose data. This tool provides the capability to develop an elementary audio classification system which identifies Hijaiyyah letter pronunciations for Quranic education purposes. Users have the ability to record samples which they can then label with target letters to train the model for real-time voice input predictions.

This study explores how Teachable Machine functions as an effective tool for recognizing Hijaiyyah letters through descriptive exploratory research. The research develops a simple voice classification model with Teachable Machine to recognize selected Hijaiyyah letter pronunciations and assesses the tool's response time and predictive performance. The research showcases how current studies on AI implementation in Quranic education can benefit from a real-world low-code solution which both educators and students can apply without additional support. Previous studies demonstrated AI's effectiveness in recognizing phoneme errors and identifying common articulation mistakes while grading Tajweed accuracy during full verse recitation (Alghamdi, Alotaibi, & Alzahrani, 2019). These implementations demand technical knowledge together with large annotated data sets and backend integration with elaborate models like convolutional neural networks (CNNs) or recurrent neural networks (RNNs) (Alsulaiman et al., 2020). Teachable Machine provides an accessible learning tool that reduces technical obstacles for both teachers and students.

Zulkefli and Ismail's (2019) review of multimedia applications in Tajweed education finds that interactive tools boost learner motivation and improve pronunciation accuracy by enabling repeated practice and self-correction. The application of AI in Quranic education introduces potential benefits but simultaneously generates various concerns.

Scholars discuss the challenges technology faces in representing both the spiritual aspects of Quran learning and the proper etiquette known as adab. Machines can recognize acoustic features but they lack the capability to assess sincerity as well as spirituality and emotional resonance. Rosni and Halim (2020) make it clear that AI and educational tools function best when they serve as supplementary aids to support qualified teachers instead of taking their place.

Technology trends and tools in Quranic Education

The implementation of digital technologies in Quranic education has experienced rapid growth during recent years. Islamic education has experienced transformative changes due to global education systems implementing online and blended learning models. The science of Quranic pronunciation through Tajweed stands as one of the areas most affected by recent educational transformations. Technological solutions including digital platforms and AI-based applications along with voice recognition systems now enable both students and teachers to teach Quranic recitation more effectively to learners who speak other languages.

Students learn Quran traditionally through direct interaction with experienced Quran teachers who gives immediate feedback on pronunciation and Tajweed rules. Numerous students encounter challenges in understanding personalized instruction because of distances and lack of sufficient time or educational resources. To address the educational limitations faced by learners, multiple technological solutions have emerged to facilitate self-directed learning and teacher support through audio playback features and phonetic visualization tools along with automated feedback systems. A number of mobile apps have been created to help students enhance their recitation abilities. The applications called Learn Quran Tajwid where it includes interactive tools like color coded Tajweed rules and features for audio playback and speech comparison. The application includes complete lessons spanning beginner to expert levels which makes it appropriate for students at any proficiency stage. Secondly are Tarteel AI where the app uses artificial intelligence to analyze recitation and deliver immediate feedback that assists users in rectifying pronunciation errors. The app enables users to detect mistakes immediately through speech recognition technology which supports self-correction. Learners can now enhance their recitation skills through these applications which allow independent assessment and enhancement without requiring teacher oversight.

The research conducted by Rosni and Halim (2020) revealed that digital Tajweed applications enhance learners' enthusiasm and participation in Quran studies. Students who consistently used language apps showed superior pronunciation abilities while remembering Tajweed knowledge for extended periods. Zulkefli and Ismail (2019) highlighted how interactive multimedia tools help improve student focus while boosting their memorization and articulation skills. Artificial intelligence has transformed Quranic education through the introduction of automated assessments of recitation quality. The correct recitation of verses by users is detected by AI systems through machine learning models that assess phonemes and articulation points. The system developed by Ibrahim, Yusoff, and Razak (n.d.) focuses on creating a Tajweed checking engine that processes audio inputs to identify violations of Tajweed rules particularly related to Sifaat (characteristics) and Makhraj (articulation points). The authors emphasize that Quranic Arabic requires better phoneme classification because it is more complex than regular spoken Arabic.

The emergence of no-code machine learning platforms like Teachable Machine

from Google enables educators to develop models without requiring programming skills. Educators can build basic voice recognition systems that identify Hijaiyyah letter sounds through these platforms. AI access becomes democratized by enabling teachers to create customized educational tools that fit their pedagogical styles and student requirements. Despite these advancements, challenges occur. Current AI models demand large datasets and intricate technical adjustments that educators often cannot access. Certain technological systems remain unable to effectively distinguish important phonetic differences in Quranic recitation. Less advanced voice recognition systems struggle with differentiating similar sounds such as ح from ه or ق from ك (Alghamdi, Alotaibi, & Alzahrani, 2019).

Digital technology integration into Quranic education provides significant opportunities for better pronunciation training while improving accessibility and learner independence. Educators now have multiple options to enhance their teaching methods through AI-powered applications and no code platforms such as Teachable Machine. The integration of digital tools into Islamic educational methods will grow as users become more digitally literate and these resources will serve essential roles for students who cannot find qualified teachers or prefer to study independently at home.

Teachable Machine in pronunciation analysis

Google's Teachable Machine stands out as one of the easiest AI tools available to researchers and educators because this no-code platform makes it possible to train basic machine learning models for image, audio and pose recognition. The application of Teachable Machine, which began as a classroom tool for rapid prototyping experiments, now extends into formal educational settings and research applications for speech recognition and pronunciation analysis (Wanyama, Onyancha, & Oboko, 2021). Teachable Machine delivers a practical and user-friendly system that identifies audio input and produces immediate classification feedback to support Quranic pronunciation studies which demand precise Arabic phoneme articulation. The process of pronunciation analysis evaluates phoneme production accuracy through examination of pitch, duration, intensity, and spectral properties. Teachers and learners find traditional pronunciation assessment tools like PRAAT and MATLAB phoneme detectors challenging because they require technical expertise and coding skills (Wang & Seneff, 2007). Teachable Machine enables users to collect annotated voice data of specific phonemes and train machine learning models through a user-friendly graphical interface. The platform excels at basic pronunciation exercises which involve identifying and differentiating Arabic letters such as ب, ت, and ث that vary according to their points of articulation and manner of production.

Research in educational fields confirms Teachable Machine's practicality for use in low-resource environments. The study by Refaee (2024) used Teachable Machine to identify Tajweed rules such as Idgham and Qalqalah from Quranic recitations. The trained models demonstrated full precision by correctly identifying all test set instances containing these rules. Teachable Machine delivers an accessible solution for Quranic pronunciation training that stands as a practical replacement for costly acoustic analysis technologies. The platform runs directly in-browser without requiring programming libraries which makes it perfect for educational purposes in schools and field settings. Teachable Machine has expanded its application scope to include various language learning contexts outside of Quranic studies. Research from Almasri and AbuSeileek (2021) demonstrates that machine learning applications in pronunciation feedback systems for English learners enhance learner autonomy while improving phoneme recognition through

real-time visual feedback. Same goes to Altalmas and his team (2018), they developed Arabic letter recognition methods by integrating Dynamic Time Warping (DTW) and Mel-Frequency Cepstral Coefficients (MFCC) to distinguish adjacent phonemes. The researchers did not use Teachable Machine for their study but their results confirm that immediate feedback and self-correction hold educational benefits which Teachable Machine can deliver through its live prediction feature.

Teachable Machine implements supervised learning models within the browser environment using TensorFlow.js for technical operations. The system extracts feature from user voice samples by using Mel Frequency Cepstral Coefficients (MFCCs) when processing speech while keeping this process hidden from users. The tool makes machine learning models more accessible but restricts users from adjusting the model and comprehending its decision-making mechanisms. The trade off becomes acceptable for educational use particularly during early Tajweed training because the objective is to assist learners with pronunciation recognition and basic correction instead of conducting clinical phonetic evaluations. Research reveals certain constraints when Teachable Machine is applied to complex speech data. The software fails to provide detailed feedback when pronunciation errors involve small vowel length modifications or phoneme substitutions typical among non-Arabic Quranic reciters (Yusof et al., 2023). The model functions effectively in silent settings but encounters a significant drop in accuracy when exposed to background noise. The tool functions most effectively in settings like classrooms and personal practice sessions because these environments provide controlled conditions.

Teachable Machine remains a valuable tool for beginners learning Quranic pronunciation in low resource settings where more sophisticated machine learning systems are not present. The browser based deployment of Teachable Machine enables seamless incorporation into learning management systems or websites while allowing exported models to be embedded directly in HTML environments. The adaptable nature of Teachable Machine makes it appropriate for online Quran learning systems that want to add intelligent feedback capabilities with minimal computational needs and no complex back-end coding requirements (Rahim, Hassan, & Ramli, 2022). Teachable Machine proves to be a beginner-friendly tool that delivers effective pronunciation analysis and feedback for Quranic learning applications. The combination of user friendly accessibility, immediate response times and flexible adaptability positions Teachable Machine as an excellent resource for both educators and students in learning Hijaiyyah letter recognition and fundamental Tajweed pronunciation. The platform does not substitute complete phonetic assessment tools but stands as an important means to make machine learning accessible in religious education settings which enables non-technical users to take advantage of AI-enhanced educational experiences.

This study aims to train a simple machine learning model through Teachable Machine for identifying specific Arabic Hijaiyyah letters. The objective of this analysis is to evaluate how well the tool can classify user-recorded pronunciations of Arabic letters without implementing advanced Tajweed correction or scoring features. The study examines Teachable Machine's accuracy in detecting and distinguishing foundational phonetic patterns within isolated letter pronunciations.

Training Process using Teachable Machine

Below are the steps required to train the Hijaiyyah model using Teachable Machine. Researcher developed a basic machine learning model with Google's Teachable Machine to identify Hijaiyyah letters through voice input. The main goal of this exploratory

study was to evaluate the classification accuracy of Arabic phonemes through basic audio recordings captured by users. The study followed a structured approach that included data collection activities, model development tasks, and testing procedures.

1. Setting Up the Teachable Machine Project

To establish this project, users created the "Audio Project" then "Audio Classification" path inside Teachable Machine. Researchers provided class labels to each Hijaiyyah letter. The study used standard Romanized transliteration to convert Arabic letters into Latin script for class names (e.g., Alif, Ba, Ta, Tha, Jim, etc.). The Romanization technique used to depict Arabic script matches established academic standards for Arabic representation in digital and educational settings (Adegoke & Abdulraheem, 2017). Latin transliteration made the labeling and visual prediction tracking more straightforward within the browser-based interface that lacks native Arabic script support. Testing phases provided more transparent feedback displays particularly for users who understand Romanized Arabic better. Users can record audio directly or upload audio files through the platform. This study used the laptop's built-in microphone to record voice samples live which reflected actual usage scenarios and reduced preprocessing requirements.

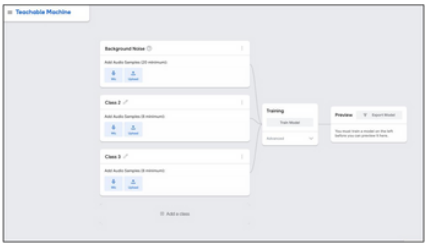

Figure 1: Audio Classification

2. Data Collection: Recording Audio Samples

This study recorded between 8 and 12 audio samples for each of the 29 Hijaiyyah letters which include Hamzah (ء). Teachable Machine requires at least 8 samples per class which informed the development of this dataset. Researcher recorded audio samples using a standard laptop microphone inside a quiet indoor space. The researcher solely recorded all voice samples to ensure consistency in tone, articulation and volume throughout all classes. Each class provided more than the required minimum number of samples despite slight variations between letters which ensured the overall dataset met the platform requirements for exploratory training. Every voice recorded maintained clear articulation alongside consistent volume levels. The researcher left one-second gaps between recordings to avoid signal overlap while ensuring high-quality audio capture. The Teachable Machine platform automatically handles segmentation and feature extraction throughout the training stage so no extra audio editing or manual trimming was necessary.

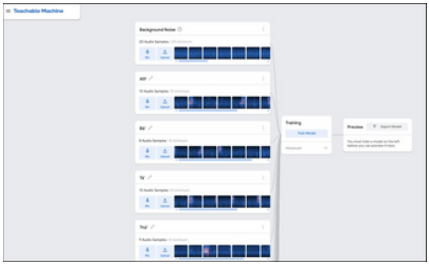

Figure 2: Audio Classification & Recording Audio

3. Training the Model

The labeled voice samples were converted into a functional machine learning model by utilizing the "Train Model" feature after completing data collection. The model training utilized TensorFlow.js entirely within the browser. The model training

process required a duration of about one to two minutes. One of the main strengths of this platform is its accessibility: The platform required no programming expertise or external library installation which enables quick deployment in classroom or research settings that lack technical resources.

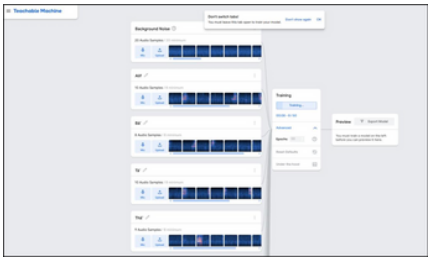

Figure 3: Training the model

4. Testing and Live Prediction

The model received its testing phase through live microphone input on the Teachable Machine interface after completing its training. The researcher pronounced each of the 29 Hijaiyyah letters multiple times. The model showed real-time prediction bars for each letter as it was spoken by visualizing the system's confidence levels across different classes. The system provided real-time visual feedback which enabled users to determine both correctly identified letters and those that were misclassified. The provided example below (Figure 4) demonstrates that the input voice received different confidence levels when identified across multiple classes. The model displayed high prediction scores for letters like Dhal (ذ) reaching up to 46%, yet other letter predictions showed an even distribution which suggests acoustic pattern overlaps. The system demonstrates sensitivity to phonetic similarities which is especially noticeable among letters sharing similar makhraj or sifat characteristics.

The test demonstrated that quick and sharp-sounding letters such as Ba', Ta', Tha' needed more exact articulation to achieve proper classification. The confidence distribution was influenced by small changes in microphone distance and background noise which highlighted the necessity of maintaining uniform recording conditions.

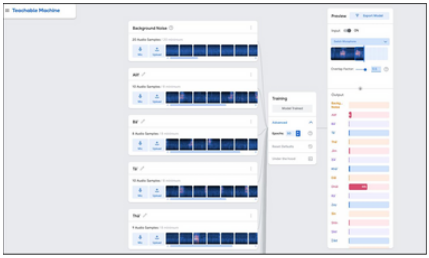

Figure 4: Live Testing results

Results and Analysis

This study tested the accuracy of a machine learning model built with Teachable Machine which recognizes the pronunciation of 29 Hijaiyyah letters including Hamzah (ء). Researcher trained the machine learning model using their own voice recordings while testing its accuracy through recitations performed by two study participants. The system produced real-time prediction percentages for every letter which demonstrated the model's confidence level in processing the spoken data. The researcher determined each letter's overall performance by averaging the model's confidence scores from both participants. The mean accuracy percentage allowed placement of each letter into one of three distinct performance levels, that are High: ≥70%, Moderate: 40–69% and Low: <40%.

The thresholds emerged from speech recognition research which uses confidence-based classification methods especially in pronunciation assessment study by Afzal et al (2023). The performance thresholds were established based on confidence classifications from speech recognition research demonstrated by Afzal

et al. (2023), Wang and Seneff (2007), and Alghamdi et al. (2019). The application of average prediction values reduced speaker variability while offering an equitable and comprehensible system to detect which letters the model identified with high confidence.

High Accuracy Letters and Observations

Five out of the 29 letters tested achieved high recognition accuracy since they reached an average prediction confidence of 70% or higher across both participants. These letters were Alif (ا), Zay (ز), ʿAyn (ع), Wāw (و), Yā' (ي) and Hā' (ه). The model demonstrated consistent accuracy in identifying these letters when speakers pronounced them clearly even though it analyzed two different voices. Several possible reasons may explain this high accuracy:

- Distinct Acoustic Patterns: The model detects Alif (ا), ʿAyn (ع), and Yā' (ي) letters more effectively because they are pronounced with vowel-like or prolonged sounds which create stable waveforms.
- Less Articulatory Confusion: Zay (ز) and Wāw (و) letters possess distinct articulation points that prevent them from being easily confused with other letters when spoken individually.
- Stable Pronunciation Across Users: The early instruction and practice of these letters in Quranic learning likely leads to their more consistent pronunciation among participants.
- Longer Sound Duration: The pronunciation of Yā' (ي) and ʿAyn (ع) features a slightly extended voiced sound which helps AI models differentiate them through amplitude and frequency analysis.

Letters with Lower Accuracy

The study concentrates on high-performing letters but highlights those letters with low mean accuracy of under 40% included Ba' (ب), Ta' (ت), Tha' (ث), Ḥā' (ح), Dāl (د), Dhāl (ذ), Sīn (س), Ḍād (ض), Ẓā' (ظ), Lām (ل), Mīm (م) and Nūn (ن). The analyzed letters demonstrated either consistently low confidence scores from both participants or exhibited significant prediction variability among different speakers. Their brief length combined with phonetic similarities and weaker pronunciation by non-native Arabic speakers during pronunciation likely explains the challenge. The results align with prior studies by Alghamdi et al. (2019) and Ibrahim et al. (n.d.) which demonstrate that basic speech recognition models struggle to correctly identify Arabic letters that differ phonetically without advanced acoustic analysis or better training data. Table 1 below represents a list of Hijaiyyah letters with each of their prediction percentages for each participant and the mean accuracy followed by the final classification levels (High, Moderate, Low).

Hijaiyyah Letters		Live prediction output (%)		Mean Accuracy (%)	Accuracy Level
		Participant 1	Participant 2		
ا	Alif	86	62	74	High
ب	Bā'	16	26	21	Low
ت	Tā'	45	21	33	Low
ث	Thā'	48	24	36	Low
ج	Jīm	56	42	49	Moderate
ح	Hā'	27	23	25	Low
خ	Khā'	64	50	57	Moderate
د	Dāl	48	28	38	Low
ذ	Dhāl	45	15	30	Low
ر	Rā'	66	56	61	Moderate
ز	Zay	68	87	77.5	High
س	Sīn	36	25	30.5	Low
ش	Shīn	67	40	53.5	Moderate
ص	Sād	71	46	58.5	Moderate
ض	Dād	16	17	16.5	Low
ط	Tā'	59	68	63.5	Moderate
ظ	Zā'	26	36	31	Low
ع	'Ayn	85	78	81.5	High
غ	Ghayn	38	47	42.5	Moderate
ف	Fā'	31	56	43.5	Moderate
ق	Qāf	17	79	48	Moderate
ك	Kāf	76	41	58.5	Moderate
ل	Lām	26	30	28	Low
م	Mīm	31	15	23	Low
ن	Nūn	32	30	31	Low
ه	Hā'	69	71	70	High
و	Wāw	86	69	77.5	High
ي	Yā'	82	81	81.5	High
ء	Hamzah	57	24	40.5	Moderate

Table 1: Live prediction output for all Hijaiyyah Letters

Discussions

Moderate The research analyzed how a Teachable Machine-trained machine learning model recognized the pronunciation of 29 Hijaiyyah letters including Hamzah (ء) using live voice input. The machine learning model was developed through training sessions using the researcher's voice and evaluated using voice recordings from two different participants. The system assessed its recognition ability for each letter by calculating a mean score from recorded prediction percentages. These mean scores were then categorized into high, moderate, or low accuracy based on a set of defined thresholds: Mean scores from 70% to 100% receive high accuracy ratings while scores between 40% and 69% fall into the moderate category and any number below 40% is considered low accuracy. The method of categorizing prediction scores established through speech recognition studies which interpret model accuracy through confidence score ranges (Afzal et al., 2023; Wang & Seneff, 2007; Alghamdi et al., 2019).

The results show that six Hijaiyyah letters were recognized with high accuracy: Alif (ا), Zay (ز), ʿAyn (ع), Wāw (و), Yā' (ي) and Hā' (ه). Both participants achieved mean prediction scores of at least 70% for these letters. Several possible factors contribute to this outcome. Models can detect these letters better because they exhibit clear articulation with consistent voicing patterns. The sounds produced by Alif (ا) and Yā' (ي) resemble vowels or elongated tones which extend slightly longer than short consonants thereby creating clearer waveform patterns. The unique articulation features of Wāw (و) and Zay (ز) prevented confusion with other letters and enabled the model to distinguish them accurately. The consistent results from both participants demonstrate that these letters are easy to pronounce and produce clear acoustic representations even with a voice-trained model.

Multiple letters demonstrated low performance in prediction accuracy with scores falling below 40%. The list of poorly performing letters consists of Ba' (ب), Ta' (ت), Tha' (ث), Ḥā' (ح), Dāl (د), Dhāl (ذ), Sīn (س), Ḍād (ض), Ẓā' (ظ), Lām (ل), Mīm (م) and Nūn (ن). The performance issues of these letters arise from their brief sound duration and similar articulation patterns along with variations in pronunciation among different speakers. The consonants Ba' (ب), Ta' (ت) function as stop consonants that need to be articulated with concise and powerful speech. These sounds become less recognizable by the model when they are not pronounced clearly and spoken too quickly. Non-native Arabic speakers struggle with articulating Dhāl (ذ) and Ḍād (ض) which often leads to inaccurate or unstable predictions from the model when their pronunciation lacks clarity. Learners often recognize Mīm (م) and Nūn (ن) as common letters but their weaker acoustic signals caused by soft pronunciation and nasal resonance make them harder to detect.

Both participant scores to create a mean provided a fair evaluation method for each letter's recognition accuracy. Participants showed similar prediction scores for letters like Hā' (ه) and Yā' (ي) but had much larger differences for letters like Qāf (ق) and Kaf (ك). Recognition results are shown to be affected by pronunciation quality and clarity even when using a standardized model. Despite the study having two participants and minimal training data for the model, it demonstrated that a no-code AI model can identify specific letters. The system excelled at recognizing letters that people pronounce distinctly, possess unique sound characteristics, and lack ambiguity with other letters. The results indicate that platforms such as Teachable Machine can be effective resources for teaching Quranic studies to beginners and self-directed learners. The educational experience becomes more valuable when students receive instant visual feedback about their pronunciation because it helps them self-correct and improves their skills as time progresses.

However, the study also revealed important limitations. The model struggled with letters that needed subtle sound distinctions and

those that sounded similar to others when recitation lacked consistency and clarity. The existing research indicates that speech recognition models encounter difficulties with Arabic phoneme classification in Quranic readings as highlighted by Alghamdi et al., 2019 and Ibrahim et al., n.d.

The study reveals that Teachable Machine shows potential usefulness as an aid in basic Quranic pronunciation education. It doesn't aim to substitute professional feedback or complex Tajweed studies but presents students with a straightforward method to receive essential articulation feedback. Subsequent studies should enhance these findings by using more varied training datasets and larger participant groups and by investigating how to combine the tool with real-time learning platforms.

Conclusion

This research examined Teachable Machine's ability to evaluate live audio inputs for the correct pronunciation of Hijaiyyah letters. The analysis of prediction confidence from two participants revealed that multiple letters including Alif (ا), Zay (ز), ʿAyn (ع), Wāw (و), Yā' (ي) and Hā' (ه) achieved consistently high recognition accuracy. No-code machine learning tools show significant promise as practical resources for foundational Quranic pronunciation exercises. The system's feedback serves as a beneficial additional educational resource even though some letters show low recognition because of their articulation difficulties. Further developments could focus on broadening the training dataset while conducting tests with diverse users to improve system recognition accuracy and stability.

References

- Adegoke, K. A., & Abdulraheem, B. (2017). Re-thinking Romanization of Arabic-Islamic script. TARBIYA: Journal of Education https://doi.org/10.15408/tjems.v4i1.5549

- Afzal, M. R., Ali, A., Mashwani, W. K., Anam, S., Zubair, M., & Qammar, L. (2023). Recitation of the Holy Quran verses recognition system based on speech recognition techniques. UMT Artificial Intelligence Review, 3(2), 00–00. https://doi.org/10.32350/umt-air.32.01

- Alghamdi, M., Alotaibi, Y., & Alzahrani, M. (2019). Automatic speech recognition systems for Quran recitation: A review. International Journal on Islamic Applications in Computer Science and Technology, 7(2), 1–10.

- Almasri, M., & AbuSeileek, A. (2021). The Effect of Pronunciation Feedback on Learner Autonomy in EFL Speaking. Arab World English Journal (AWEJ), 12(1), 50–65. https://doi.org/10.24093/awej/vol12no1.4

- Alsulaiman, M., Muhammad, G., Alghamdi, M., & Alhussein, M. (2020). Deep learning techniques for Arabic speech recognition: A review. Journal of King Saud University - Computer and Information Sciences, 32(6), 660–670. https://doi.org/10.1016/j.jksuci.2018.09.008

- Ibrahim, N. J., Yusoff, M. Y. Z. M., & Razak, Z. (n.d.). Improve design for automated Tajweed checking rules engine of Quranic verse recitation: A review. Centre of Quranic Research International Journal.

- Learn Quran Tajwid. (2023). Learn Quran Tajwid - Apps on Google Play. https://play.google.com/store/apps/details?id=com.bi.learnquran

- *Mohd Yunus, N., & Ahmad, W. M. R. W. (2021). Teknologi Kecerdasan Buatan dalam Pendidikan Islam: Tinjauan Literatur dan Arah Masa Hadapan. Jurnal Pendidikan Malaysia, 46(1), 23–35. https://doi.org/10.17576/jpen-2021-46.1-03*

- *Rahim, N. F., Hassan, A. R., & Ramli, R. (2022). Keberkesanan aplikasi mudah alih terhadap pembelajaran bacaan al-Quran dalam kalangan pelajar sekolah menengah. Jurnal Pendidikan Islam dan Bahasa Arab, 12(1), 33–48.*

- *Refaee, M. (2024). Tajweed rules extraction from the Quran using Teachable Machine application from Google. ResearchGate. https://www.researchgate.net/publication/380909869_Tajweed_rules_extraction_from_the_Quran_using_teachablemachine_application_from_google*

- *Rosni, N. A. H., & Halim, A. N. A. (2020). Penggunaan aplikasi mudah alih Learn Quran Tajwid dalam pengajaran dan pembelajaran al-Quran. Jurnal Pendidikan Islam, 8(2), 52–65.*

- *Tarteel AI. (2023). Tarteel: AI-powered Quran memorization app. https://www.tarteel.ai/en*

- *Wang, C., & Seneff, S. (2007). Automatic assessment of student speech for foreign language pronunciation. Proceedings of the Human Language Technology Conference of the NAACL, 89–92.*

- *Wanyama, P., Onyancha, I., & Oboko, R. (2021). Simplifying AI education using no-code tools in classrooms. International Journal of Computer Applications, 183(2), 1–7. https://doi.org/10.5120/ijca2021921263*

- *Yusof, N. H. M., Mahmud, A., & Salleh, M. M. (2023). Speech Recognition Challenges in Quranic Arabic Learning for Non-Arabic Speakers. Jurnal Teknologi, 85(3), 101–110.*

- Zulkefli, N. A., & Ismail, N. (2019). Keberkesanan penggunaan multimedia interaktif dalam pembelajaran hukum tajwid. Jurnal Penyelidikan Sains Sosial (JOSSR), 7(2), 17–28.