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**DEVELOPMENT OF *QALQALAH* PRONUNCIATION STANDARDS IN AL-QURAN USING SPECTROGRAM APPLICATION**

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*Qalqalah* is an attribute of letter in rules of Quranic recitation which has a pronunciation method and different levels based on its position in al-Quran. Although discussion in *tajweed* discipline already has suggested various pronunciation methods for *qalqalah*, the percentage of error in *qalqalah* pronunciation is still high among the readers of Quran. Currently, methods for pronunciation of *qalqalah* and its levels are also explained only through *talaqqi* and *tajweed* books, which are studies that do not involve measurement. Therefore, this study investigated *qalqalah* and its standardised levels based on aspect of phoneme, *harakat*, duration ratio and formant through spectrogram application. This study sets three objectives to achieve. First, to recognise attributes of letters for three levels of *qalqalah* based on phoneme details in spectrograms. Second, to analyse the difference of *harakat* value, duration ratio and formant value of three *qalqalah* levels based on spectrograms. Third, to suggest standards of *qalqalah* levels based on spectrogram application. Exploratory design, through qualitative and quantitative methods, was employed. Data collection was done through library research and observation of spectrographic display of *qalqalah* recitation samples. Data from library research were analysed through a content analysis method. Data of interviews with experts were analysed based on semi-structured interview analysis. Spectrogram qualitative data were analysed through

audio analysis. Meanwhile, spectrogram quantitative data were analysed through one-way analysis of variance (ANOVA) test, Tukey post-hoc test and *t*-test for two independent samples. Main findings of this study are categorised according to objectives of study. First, there is no difference in phoneme pattern for all *qalqalah* levels. Second, from *harakat*, ratio and formant aspect, all *qalqalah* levels were different. Meanwhile, from aspect of differences between formant of *qalqalah* and preceding diacritic, all *qalqalah* levels were different from preceding diacritic. Third, these standards for *qalqalah* pronunciation through spectrograms will provide added value in *tajweed* learning besides the main method *talaqqi* and *musyafahah*.

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**PEMBINAAN PIAWAIAN SEBUTAN QALQALAH DALAM AL-QURAN  
MENERUSI APLIKASI SPEKTROGRAM**

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Qalqalah merupakan satu sifat huruf dalam hukum bacaan al-Quran yang mempunyai kaedah sebutan dan tahap yang berbeza berdasarkan kedudukannya dalam al-Quran. Walaupun perbincangan ilmu tajwid sedia ada mencadangkan pelbagai kaedah untuk mengajar cara sebutan qalqalah, namun peratusan kesalahan sebutan qalqalah masih lagi tinggi dalam kalangan masyarakat awam. Setakat ini, kaedah sebutan qalqalah dan tahap-tahapnya hanya dijelaskan melalui *talaqqi* dan pembelajaran kitab-kitab tajwid tidak melibatkan pengukuran lain. Oleh itu, kajian ini mengkaji piawaian qalqalah dan tahap-tahapnya berdasarkan aspek fonem, harakat, nisbah tempoh serta forman menggunakan aplikasi spektrogram. Kajian ini menetapkan tiga objektif untuk dicapai. Pertama, mengenal pasti sifat huruf ketiga-tiga tahap qalqalah berdasarkan ciri fonem dalam spektrogram dan kitab tajwid muktabar. Kedua, menganalisis perbezaan nilai harakat, nisbah tempoh dan nilai forman ketiga-tiga tahap qalqalah berdasarkan spektrogram. Ketiga, mencadangkan piawaian tahap qalqalah berdasarkan aplikasi spektrogram. Reka bentuk penerokaan melalui kaedah kualitatif dan kuantitatif telah digunakan. Pengumpulan data dilakukan melalui kajian perpustakaan dan pemerhatian penyelidik kepada paparan spektrogram terhadap sampel bacaan qalqalah. Data kajian perpustakaan dianalisis menggunakan kaedah analisis kandungan. Data temubual pakar dianalisis berdasarkan analisis

temubual separa berstruktur. Data kualitatif spektrogram dianalisis melalui analisis audio, manakala data kuantitatif spektrogram dianalisis melalui ujian analisis varians sehala (*one-way ANOVA*), *post-hoc* Tukey serta ujian *t* bagi dua sampel tidak bersandar. Hasil utama kajian dibahagikan berdasarkan objektif kajian. Pertama, tiada perbezaan corak fonem antara semua tahap qalqalah. Kedua, dari aspek harakat, nilai nisbah dan forman, semua tahap qalqalah berbeza. Dari aspek perbezaan forman qalqalah dengan baris sebelumnya, semua tahap qalqalah berbeza dengan baris sebelumnya. Ketiga, piawaian sebutan qalqalah melalui spektrogram ini dapat memberi nilai tambah dalam pembelajaran ilmu tajwid di samping kaedah utama iaitu *talaqqi* dan *musyafahah*.