ETHNOMATHEMATICS IN *TAJWID* SCIENCE: ANALYSIS OF MATHEMATICS CONCEPTS IN QUR'AN READING LAWS

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Abstract: The study departs from the understanding that mathematics is often seen as a science discipline that separate from daily-life realities; however, in the contexts of Islamic cultures, specifically in the *tajwid* science, there is strong relation between mathematics and religious practices. The focus of the present study is revealing how numerical approaches and mathematical patterns are used in the instructional processes of the Qur'an reading, specifically related to the laws of *mad* reading. The method used i of the qualitative approach with an ethnograhic research model through in-depth interviews with *ustadz*s and literary reviews classical and contemporary manuscripts related to the *tajwid*. Findings show that the *tajwid* science has integrated the mathematical concepts of duration measurement, rhythm patterns, and numerical ratios in its instructional system, indicating that there are ethnomathematics elements in the contexts of the Moslem cultures. This analysis shows that the numerical approach in the tajwid does not only function as an aid tool, but it also reflects the richness of the Moslem cultures and traditions. This study has widened the understanding that mathematics contextually has a role in the religious practices and instructional processes of the *tajwid* science.

Keywords: etnomatematics, tajwid science, mathematical concepts

INTRODUCTION

Mathematics has long been regarded as a science discipline that is neutral and free from cultural influences and social values (Bishop, 1993). Mathematics is related to quantity, structure, space, and change. In the freedom curriculum, at school, mathematics is taught as a subject matter covering the learning of facts and concepts and materials that are regarded as universally functioning. This way, in the contexts of education, mathematics encompasses the cluster of knowledge that includes algorithms, axioms, and theorms. In relation to this, ethnomathematic programs are developed to challenge the

proposition that mathematics is universal and free from the influences of cultures (Rosa & Orey, 2006). The term ethnomathematics is first introduced by Ubiratan D'Ambrosio, a study branch which explores the relations between mathematics and cultures with the intention to understand the relations between mathematics and cultures and acknowledge the divergents of the ways of thinking among various cutures. Hammond (2000) states that ethnomathematics is research in the aspects of mathematics that are related to cultures; including comparative studies among mathematics in the various human cultures, especially in the contexts how mathematics influences and is influenced by values and beliefs among community groups.

Etnomathematics is a product of the interaction between cultures and mathematics. Understanding of the relations among these concepts can be used to elevate the effectiveness of mathematics learning, especially in the classroom environment which is multicultural (Wahyuni & Anggriani, 2023). Studies on the aspects of mathematics that are related to cultures, etnomathematics, are focused on the comparative mathematics within various human cultures. In the mean time, cultures refer to the products of the activities and creativities of the human minds including beiefs, arts, and traditional habits. Cassirer (1944) divides culture into five aspects; namely: (1) spiritual life, (2) language and literature, (3) arts, (4) history, and (5) knowledge. According to these aspects, culture can be understood as something that influences knowledge levels and covers the ideological systems in the human minds. Therefore, in daily life, culture is abstract in nature.

Mathematics is often seen as a science discipline that is entirely separated and has no relation to daily-life realities. But, in the contexts of the Moslem cultures and traditions, many aspects of mathematics can be found in the religious practices, one of which is in the "tajwid" science. *Tajwid* is the science that instructs how to read the Qur'an correctly, having various rules that indirectly apply mathematics concepts. The *tajwid* science has an important role in preserving the method of reading the Qur'an by strict formulas, following rules that are handed down fom generation to generation.

Research in ethnomathematics has much been done focusing on the relation between mathematics and local cultures such as in traditional music instruments, dances, and numbering in indigenous people (Agasi & Wahyuono, 2018; Bishop, 1993; D'Ambrosio, 2001; Fitriani, 2022; Taufik, 2023). In addition, there is a study by Fitri Apriliawati (2023) with the title "Etnomathematics: Analysis of Mathematics Concept on the Activity of Reading *Ratib Al-Haddad*", a study that involves mathematics concepts in a religious field. However, a limited number of studies have been conducted

that specifically relate ethnomathematics concepts with the *tajwid* science and the rules of reading the Qur'an. Thus far, analyses on the *tajwid* science have focused on linguistic and phonetic aspects, while numerical elements and mathematic patterns that are contained in them have not been studied in details.

It is why the present study is here as an effort to fill up the gap by anayzing mathematics concepts that are attached in the rules of reading the Qur'an through an approach to etnomathematics. This study is not only supposed to enrich the realm of the *tajwid* science, but it is also supposed to broaden the gamut of etnomathematics by inserting a unique Moslem cultural practice. Besides, the study is going to show that the traditional *tajwid* instruction has been using a numerical approach through *harakat* counting, which opens the opportunity to develop an instructional method that integrates mathematics concepts in order to make it easier to understanding the laws of reading. In so doing, this study has a novel value and gives important contributions in developing interdisciplinary analyses among mathematics, cultures, and the *tajwid* science.   In addition, this study has a role in broadening the arena of etnomathematics by inserting the *tajwid* science as part of the practices of cultural mathematics in the Moslem traditions to simultaneously become a reference to the development of more innovative learning methods of Qur'an reading.

This study is focused at how *tajwid* science adopts the numerical approach in the learning of the Qur'an reading, more specifically related to the counting of the reading duration in the *mad* (lengthening) law. Besides, the study analyzes the numerical rules that are used to lengthen or shorten the *harakats* (sounds), the mechanism of scaling of the length of the *harakat* in the *mad* reading, the mathematical pattern or ratio in the *mad* law, and the understanding of how the *tajwid* science is related to mathematics concepts in the contexts of the learning of the daily practices of the Qur'an reading.

METHOD

The present study is a piece of qualitative research using an etnographic method completed with literature analyses and in-depth interviews. This is to describe the mathematics concepts that emerge in the laws of the Qur'an reading in the *tajwid* science. The study is furthermore an explorative quest in the intention to probe into the relations between the *tajwid* science and mathematics concepts in the ethnomathematic perspectives.

The approach to the study refers to experts' schools of thoughts, such as James P. Spradley, Ach. Fatchan, and Marvasti, whose methodology has then been adopted by the researchers. The research steps taken can be seen in Table 1.

Tabel 1. Methodological Steps of the Study

Step	Main Activity
Deciding on the project	Selecting topics and contexts of the ethnomathematics in the *tajwid* science.
Developing questions	Writing observation guides and interview texts
Collecting Data	Doing participative observation, interviewing experts in *tajwid* science, documenting from the classical *tajwid* script, i.e the "Syifaul Jinan" manuscript
Recording Data	Making field notes during interviews, documenting visual manuscripts
Analyzing Data	Conducting data reduction, presentation, analyses, and drawing conclusion
Writing Report	Presenting research results in descriptive texts

The data collection of the research involved primary and secondary data. The main data were obtained from interviews with two experts in the *tajwid* science who were also *ustadzs* or teachers of Qur'an in one of the Moslem boarding schools in Yogyakarta. The secondary data were obtained from the literature study of the classical manuscript (Figure 1) popularly used among the *salaf* Moslem boarding schools discussing the basics of the *tajwid* science, called the script "*Syifaul Jinan*" written by Syaikh Sa'id ibn Sa'd An-Nabhani Al-Hadrami. This old book was a *syarah* [explanation] writing in the Javanese language which explained in details the Arabic version, "*Hidayatush Shibyan*", written by Kyai Ahmad Muthahhar bin Abdurrahman.
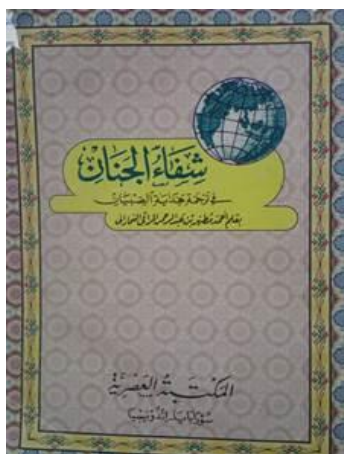

Figure 1. The manuscript "*Syifaul Jinan*"

Interwiews were conducted in the semi-structured format with the interview topics around the *tajwid* science focusing on how the law of *mad* reading was taught, how *mad* durations were measured, and whether numerical patterns or structures were involved. Data were analyzed by the thematic technique; namely, grouping the answers from the resource informants into categories pertinent with the ethnomathematic indicators.

Details of the interview guides are presented in Tabel 2.

Table 2. Interview Instrument

No	Question
1.	What is the instructional system of the *tajwid* science like; is there a numerical approach in explaining the reading rules?
2.	In the *tajwid* science, is there a time counting or specific duration for reading long and short sounds in the Qur'an recitation?
3.	How are the concepts of pronouncing long and short *harakats* in the *tajwid* science determined; is there a numerical rule applied?
4.	What is the measuring system of the length of reading in the law of *mad* reading like?
5.	Is there in the *mad* reading rules a certain mathematic pattern such as numerical comparison or certain ratio?
6.	How do you see the relations between the *tajwid* science and mathematics concepts in daily-life practices?

The obtained data were then analyzed by the techniques of data reduction, data presentation, and drawing conclusions. Data analysis went through the processes of identification of mathematical patterns in the *tajwid* science, construction of categories based on the interview results and literature reviews, and interpretation of the relations between the *tajwid* concepts and mathematics elements in the reading rules. To guarantee the data validity of the study, the researchers applied the source and technique of triangulation methods. The source triangulation was done by making use of two informants originating from different backgrounds of *tajwid* learning (*Ustadz* A, UA and *Ustadz* B, UB). The different backgrounds gave contributions in verivying the consistencies of information that emerged concerning *mad* reading rules. Meanwhile, the technique triangulation was done by supplementing interview data through documentary reviews of classical *tajwid* books such as the *Syifaul Jinan* manuscript and contemporary *tajwid* literatures. This documentary analisis was intended to substantiate the coherence between the information pieces given by the informants and the textual references concerning the number of *harakats*, structure of the reading laws, and numerical patterns that were used.

RESULTS AND DISCUSSION

Interview data show that there are relations between the *tajwid* science and certain interesting mathematics concepts. In these relations, it can be seen that the *tajwid* science is taught systematically through the numerical approaches. In this manner, the duration and length of the the reading are regulated by certain laws and have close relations with mathematics concepts in the analysis and understanding of the Qur'an reading (Al-Qattan, 2001).

Numerical Element in *Tajwid* Instructional Approach

The instructional system of the *tajwid* science generally applies a method which combines theories and practices such as lecture speeches, practice drills, *talaqqi*, and group discussions so that students understand in-depth the laws of reading correctly (Astuti, 2020; Fatimah *et al*., 2019). From the results of the interviews with the two *tajwid* expert informants, it is found that the *tajwid* instructional proceeding is generally done gradually and structured. Although not explicitly mentioning the term 'mathematics', the numerical practice is used in the instructional process (Sya'roni, 2018). One of the examples is the use of numbers to indicate durations in the *mad* law, e.g. the pronunciation is to be prolonged 2, 4, or 6 *harakat*s. This can be seen in the following quotes from the interviews:

UA   *"Teaching tajwid is usually a combination of theory and direct practice. Thus, the students or santris are led to the theories, first, such as laws for 'nun mati', 'mim sukun', mad, and so on; and only after that are they allowed to read the Qur'an with the teacher. Well, concerning numbers, actually they are not formally mentioned in the classical books, but in practice, there is counting, particularly for mad reading. For example, the reading of the mad thabi'i has 2 harakats, obligatory mad can have 4 or 6 harakats. So, although not mentioning "mathematics approach", these numerals are important to determine the length of the reading."*

UB   *"With the talaqqi (learning directly from the teacher), students sometimes have a group discussion among themselves. Concerning numbers, they are actually there, especially when talking about mad reading; however, numbers here are not actually complicated mathematics; it is more to measuring the length of reading only like the reading of mad can count to 2, 4, 5, up to 6 harakats. So, the numbers are used to assist to have a more appropriate reading, not to count mathematically."*

This analysis shows that, mathematics elements, especially in the forms of numbers and counting, have become inseparable part of the *tajwid* instructional processes even though they are not expressed in formal mathematic contexts. In the manuscript Syifaul Jinan, in the chapter of the *mad* character and its divisions (Figure 2), it is explained that, language-vice, *mad* means "add"; meanwhile, according to *tajwid* experts, *mad* is prolonging the pronunciation of a sound that needs to be prolonged.
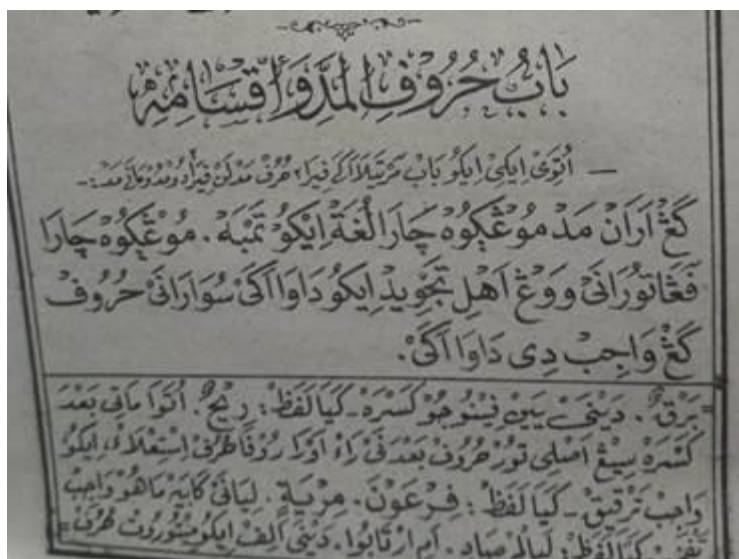
Figure 2. Meaning of *Mad*

Duration of Long and Short Reading in *Tajwid*

In the *tajwid*, the duration of the lengthening of the *mad* reading is not measureed in time units, such as the seconds, but in the concept of *harakat*; that is, a span time determined by a certain physical movement or tempo when reading. In Figure 3, it can be seen in the left-most column, "the length", in the manuscript *Syifaul Jinan*, is marked by one "*alif*", in which 1 alif is equal to 2 *harakat*s. For example, the *mad* "thabi'i" is 1 alif or "is read in 2 harakats"; the compulsory *mad* "muttasil", has 2 *alif*s or 4 *harakat*s; and the mad "jaiz munfasil" is similar to *mad* "thabi'i" or compulsory *mad* "muttasil", that is between 2 and 6 *harakat*s (Sa'dijah, 2021). Although the *harakat* unit of length is relative in nature, its use is standard practice that is known and done by Qur'an readers. This shows that there is a system of measurement of contextual time which contains a mathematical element traditionally.

In terms of the differences in the duration in pronuncing the sound, the two resource informants agree that such is determined by standardized practice. Units of short pronunciation, the *fathah*, *kasrah*, and *dhommah*, have 1 *harakat*; meanwhile, the long units (*mad*) are based on certain determined *harakat*s. The numbers 2, 4, and 6 *harakat*s are not only practically useful in instruction, but they also reflect an important numerical measurement in the Qur'an reading (Hidayat, 2021). This shows that the *tajwid* contains structures that are coherent with basic principles of mathematics, particularly in the cases of measuring and adding the time of reading.

Figure 3. Examples of *Mad* Readings

Measurement in the *Tajwid*

One of the main parts in the *tajwid* is the measurement of the reading length of sounds in *harakat* units, which implicitly has a mathematic value to regulate rhythms and fluency in the Qur'an reading (Surya, 2019). The length of the sound reading does not only comply to the *syariat* regulations, but it also must reflect the orderliness of numbers that can be appraised by mathematical approaches. In the laws of the long *mad*s, the duration of the long pronunciation is determined by the number of the harakats. Each *mad* category has its own standard based on the rhythm punches or certain movements. For example, the *mad* "*thabi'i*" is pronounced in two *harakat*s, which practically means two punches in a stable tempo. This quantification system has been in use from generation to generation in *tajwid* instruction and assist in preserving the consistency of the Qur'an reading, indirectly applying the measurement principles in traditional mathematics. This is evident from the results of the following interviews with the research informants:

UA   *"The length is measured in harakat units, as has been explained. One harakat can be equalized with one punch or normal pulse. Hence, in order not to be too fast or too slow, the teqcher usually gives examples and practices until the santris are able the follow the rhythm correctly. So, actually it is a kind of natural standardization built through drills and listening to the teacher but, still, it is based on these numbers 2, 4, or 6 harakats."*

UB   *"Yes, there are. We call these harakats. The harakat is a length of time to read. For example, the length of a mad reading can be 2 harakats, 4 harakats, or even 6 depending on the mad category. But we are not using a stopwatch or other measuring tools, okay; we usually use feelings or finger punching in order to get the right measure. So, although the counting is not exactly precise, there are aiding guides so that our reading is harmonious to listen to and is in line with the existing rules."*

Comparison Patterns

In the *mad* laws, there are also mathematical concepts other than measurement; there is a regularity in the forms of comparisons. These ratio patterns in the rules of *madd* indicate a regularity of recitation duration that is relative among different types of *madd*, rather than a mathematical ratio that can be freely scaled. For example, the reading of *mad* "*thabi'i*" which has a duration of 2 *harakat*s has a ratio of 1:2 to the compulsory *mad* wajib "*muttasil*" with 4 *harakat*s. Even, if it is compared with a reading of 6 *harakat*s, like *mad* "*aridh lissukun*", it can be seen a ratio of 1:3. This indicates that there is a mathemtical regularity and structure that underlie the laws of reading, such that the concepts of *tajwid* can be seen as part of an ethnomathematics study, particularly in the cases of ratios and proportions.

UA   *"Wee, this is interesting. The tajwid science and mathematics are actually related although we are in different worlds. In tajwid, we train students in reading using rhythms, patterns, and numbers. Well, in mathematics, there also things like that? There are comparison patterns, as far as I know. See, in teaching our santris, we often use numbers and repetitions to help them understand such as when we discuss the harakats or differentiate mad categories. So, in my opinion, mathematics concepts enter into tajwid, although they are not directly mentioned."*

UB   *"Seems like there is, okay; even though the tajwid is more to religious science and art of reading. But, sometimes we do need numbers, counting, and rhythms to assist us in teaching. Hence, when teaching about mads, for example, we explain "this needs 2 harakats, and this 4." Well, we have entered into mathematical concepts, haven't we? Although indirectly. We can say that mathematics in tajwid is more like an aid tool; not the core of the science."*

Based on the results of the interwiews with the two resource informants, it can be concluded that there is a strong relation between the *tajwid* science and mathematics concepts, especially in the aspects of time measurement, rhythm patterns, and reading structures. This phenomenon is a real example of ethnomathematics; i.e. a study of the relation between mathematics and cultures in daily lives (Rizky & Nasution, 2024). The *tajwid* science emphasizes the religious aspects and arts of reading; meanwhile, mathemtics functions as an aid to standardize reading lengths in order that uniformity and beauty of the Qur'an reading are guarded (Nursoim, 2022). In daily practice, the *tajwid* teacher uses numbers and rhythms to explain the length of the reading. According to these interview results, it can be concluded that there is a strong relation between the *tajwid* science and mathematical concepts, specifically in the aspects of time meaurement, rhythm patterns, and reading structures.

CONCLUSION

Etnomathematics has a strong relation with the *tajwid* science in the contexts of the Moslem religion. Mathematics concepts, especially time measurement, rhythm patterns, and reading structures indirectly or directly, are used in instructional processes and Qur'an reading practices. Use of numbers and ratios in the lengths of the *mad* reading indicates that the *tajwid* contains numerical elements that are coherent with mathematics basic principles. Besides functioning as a learning aid, the numerical approach enriches the cultural aspects and Moslem traditions, simultaneously opening the path to the development of *tajwid* instructional methods that are innovative and interdisciplinary-based. In such a way, the present study has widened the scope of etnomathematics into religious practices, particularly in the *tajwid* science and confirmed that cultures and mathematics are inter-related in the daily lives of the Moslems in reading the Qur'an.

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