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Ethnomathematics Study: Arithmetic Sequence Patterns in the Rhythms of Traditional Musical Instruments of the Likurai Dance in Malaka Regency, East Nusa Tenggara

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Abstract

This research is motivated by the importance of understanding the relationship between culture and mathematical concepts in community life. Ethnomathematics provides a field of study to reveal the existence of mathematical concepts embedded in the daily activities, traditions, and cultural practices of society. This study aims to identify and analyze arithmetic sequence patterns found in the traditional musical instrument of the Likurai dance called Bibiliku, which is an essential instrument in the Likurai dance of the community in Malaka Regency, East Nusa Tenggara. This study employed a descriptive qualitative approach within the framework of ethnomathematics, using participatory observation, in-depth interviews with a traditional leader, a dancer, and a trainer, as well as audio-visual documentation. The findings reveal that the rhythmic patterns of *Bibiliku* in the "tabere" style form arithmetic sequences with a common difference of 2. Odd beats generate the sequence 1, 3, 5, 7, …, while even beats produce 2, 4, 6, 8, …. These results indicate that the rhythmic regularity of traditional music reflects mathematical concepts, particularly arithmetic sequences, although not formally defined by the community. Therefore, this study confirms that mathematics naturally exists within cultural practices. The findings of this study can serve as contextual learning resources for teaching arithmetic sequences in mathematics education while also contributing to the preservation of cultural heritage.

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Introduction

Mathematics and culture have a close relationship, influencing and complementing one another. Although mathematics is often perceived as an abstract discipline separate from everyday life, many mathematical concepts actually originate from cultural practices within society. One field of study that highlights this connection is ethno-mathematics, which examines how mathematical elements are present and applied in cultural activities, traditions, and societal artifacts. According to D'Ambrosio (1985), ethno-mathematics serves as a bridge between culture and formal mathematics by recognizing the diversity of mathematical approaches across different communities. Ethno-mathematics can also function as a link between culture and mathematics education.

Ethno-mathematics is one form of integrating character and literacy into mathematics learning. Through an ethno-mathematical approach, the learning process does not only focus on mastering abstract concepts, but also connects them with existing cultural contexts (Abroriy, 2020). In line with this, Mei et al. (2020) argue that mathematics is a form of culture embedded in people's lives wherever

they are, whether consciously or not. This is reflected in various cultural activities that contain mathematical elements. One example can be found in Malaka Regency, East Nusa Tenggara Province, through the traditional *Likurai* dance, which is commonly performed at customary ceremonies, celebrations, and in welcoming important guests. One of the main musical instruments accompanying this dance is a traditional drum known as the *bibiliku*.

The traditional musical instrument *bibiliku* functions not only as a musical and aesthetic accompaniment, but also contains specific patterns that can be analyzed mathematically, such as the number of beats, sequence of tones, arrangement of players, and rhythmic structures that form numerical sequences. These number patterns follow certain rules, whether arithmetic, geometric, or other forms. In the context of music, such patterns may emerge from the number of beats, the duration of tones, or repeating rhythmic structures.

Several ethnomathematics studies have examined the relationship between mathematics and culture, including in woven fabric motifs (Sumartono, 2022; Zaky & Khotimah, 2024), traditional architecture and paintings (Amsikan & Nahak, 2017; Funan & Mamoh, 2019; Pertiwi & Budiarto, 2020; Prahmana & D'Ambrosio, 2020), as well as music, dance, and traditional musical instruments (Hayuhantika & Rahayu, 2019; Ivoni Susanty, P., & Kharisudin, I., 2019; Indrawati et al., 2021; Kumoro et al., 2022; Novitasari et al., 2022; Fitriani, 2022; Astria & Kusno, 2023; Bau & Fallo, 2025; Ritawati, 2025; Hijriati et al., 2026). However, specific studies on number sequence patterns in the *bibiliku* within the *Likurai* dance are still limited. The novelty of this study is the exploration of arithmetic sequence patterns in the traditional musical instrument *bibiliku*.

The purpose of this study is to identify and analyze arithmetic sequence patterns in the *bibiliku* in Umatoos Village, West Malaka District, Malaka Regency, East Nusa Tenggara Province, using an ethnomathematics perspective. The results of this study can serve as contextual learning resources for teaching arithmetic sequences in mathematics education while also contributing to the preservation of cultural heritage.

Methods

This study employed a descriptive qualitative approach with an ethnomathematics perspective. This approach was chosen because it is able to reveal mathematical concepts that naturally emerge in culture, traditions, and social practices through observation, interviews, and contextual as well as holistic interpretation. The study was conducted in Umatoos Village, West Malaka District, Malaka Regency, East Nusa Tenggara Province, from June to August 2025. The research subjects consisted of 8 bibiliku players (drummers), 2 dancers, and 2 traditional/cultural leaders who possess an understanding of the history and musical rules of the Likurai dance. The data sources in this study included primary and secondary data. Primary data were obtained through direct observation of Likurai dance performances, in-depth interviews with 1 drummer, 1 drummer who also served as a trainer, and 1 senior traditional leader, supported by audio/video documentation of performances for rhythm pattern analysis.

Drummers and dancers were selected as data sources because of their direct involvement in Likurai performances and their understanding of rhythm patterns, musical rules, and the cultural practices related to the use of the bibiliku musical instrument. Therefore, they were able to provide authentic and contextual data regarding arithmetic sequence patterns that emerge in the cultural practices of the community. In addition to primary data, this study also utilized secondary data in the form of literature on the Likurai dance and the bibiliku musical instrument, as well as previous studies related to ethnomathematics and traditional music.

Data collection was carried out through several methods: (1) participatory observation, by directly observing the process of playing the bibiliku musical instrument and recording the number and sequence of beats within one rhythm cycle; (2) in-depth interviews, by exploring information regarding the meaning, function, and musical rules from traditional leaders and musicians; and (3) documentation, by using audio/video recordings to ensure the accuracy of beat and rhythm data. The rhythm data obtained through audio/video documentation of Likurai dance performances were then transcribed into sequences of beats based on the striking patterns of the bibiliku musical instrument. Each beat was identified and arranged sequentially to facilitate the mathematical interpretation of the emerging rhythm patterns. Furthermore, the beat patterns were analyzed to identify numerical regularities, particularly arithmetic sequence patterns based on equal differences between beats. The transcription results of the rhythm patterns are presented in Figure 1.

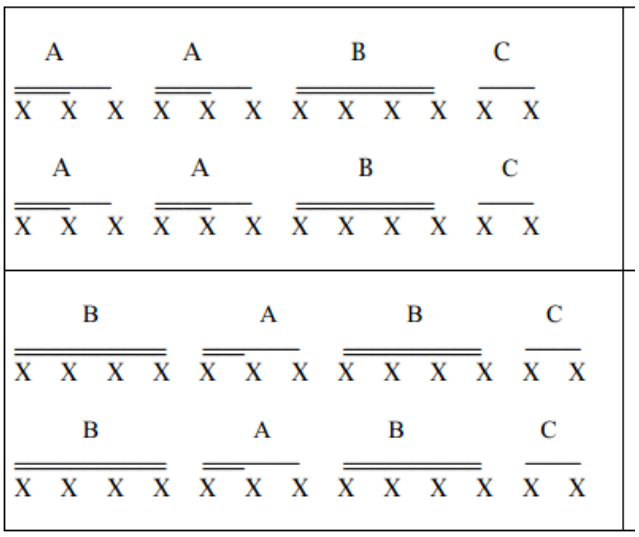

Figure 1. Basic Rhythm Pattern Transcription

The analysis of notation and rhythm patterns in this study involved traditional musicians, artists, and traditional leaders experienced in Likurai dance performances. Their involvement aimed to ensure the accuracy of rhythm interpretation, the appropriateness of musical patterns, and the cultural validity of the analysis results.

The data were then analyzed through several stages: (a) data reduction, by filtering and grouping the musical beat data based on the type of instrument and the sequence of patterns; (b) identification of

number patterns, by transforming the rhythm data into arithmetic sequences; (c) mathematical interpretation, by analyzing the regularity of the patterns using mathematical concepts; and (d) cultural contextualization, by relating the mathematical findings to the cultural meanings embedded in the Likurai dance in accordance with ethnomathematics principles.

To ensure the validity of the data, this study applied source triangulation by comparing information obtained from drummers, traditional leaders, and documentation, as well as technique triangulation through the use of observation, interviews, and documentation methods. Data validation was also conducted through member checking by presenting the results of the analysis of bibiliku rhythm patterns as arithmetic sequences to the drummers and traditional leaders to ensure that the transcription, rhythm interpretation, and cultural meanings were consistent with their experiences and understanding. In addition, this study employed peer debriefing through discussions with mathematics lecturers and traditional leaders who are experts in traditional music to examine the accuracy of the mathematical analysis and cultural interpretation of the rhythm patterns of bibiliku in the Likurai dance.

Result and Discussion

The results of the observation indicate the presence of sequence patterns reflected in the rhythm produced by *the tabere* beats, which are one type of stroke on the Likurai drum *(bibiliku)* within a particular cycle (Figure 2).

Result

Cultural Context of the Likurai Dance

Based on an interview with Pius Seran Soe, the Likurai dance is a traditional dance of the community in Kabupaten Malaka that has been known since around the 18th century as a welcoming dance for warriors returning from war. The dance is generally performed by eight female dancers who play the drums and two male dancers serving as peronggeng, carrying a traditional sword called surik as a symbol of bravery and victory.

Characteristics of the Bibiliku Musical Instrument

The researcher conducted an interview with a senior drummer, Yasintha Seuk. The interview results indicate that the name *bibiliku* comes from two Tetun words, namely *bibi*, meaning goat, and *haliku/liku*, meaning to hold or clamp under the arm. Thus, bibiliku can be interpreted as a musical instrument made from goat skin and played by being held under the arm. The goat skin is attached to a cylindrical wooden frame. This instrument is played by striking it, producing distinctive rhythmic sounds, and serving as an essential component in accompanying the Likurai dance.

Likurai trainer Yuliana Luruk explains that the bibiliku drum is made from goat skin attached to a cylindrical wooden frame with a length of approximately 30 cm to 50 cm and a diameter of 15 cm to 20 cm. The goat skin surface functions as the part that is struck to produce sound. The bibiliku is played by being held under the armpit, between the arm and the body. The minimum number of performers in

a Likurai performance is ≥ 8 female dancers and 2 male dancers, resulting in at least ≥ 10 performers in total.

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Furthermore, the researcher conducted an in-depth analysis of audio/visual recordings to determine and describe the rhythmic patterns of the *tabere* beats produced by the traditional drum (*bibiliku*). In one cycle of *bibiliku* performance, the rhythm of the *tabere* beats follows a standard pattern as shown in Table 1, where A = ♬♪, B = ♬♬, and C = ♪♪. When converted into staff notation, it appears as shown in Figure 3.

Figure 2. Likurai dancers playing the drum (*bibiliku*)

Figure 2 represents a real-life visualization of the patterns previously described in Figure 1, Figure 3 and Table 1. In the image, the dancers performing the traditional Likurai dance play the bibiliku musical instrument in a consistent manner, following the established rhythmic patterns and the defined striking rules of A, B, and C.

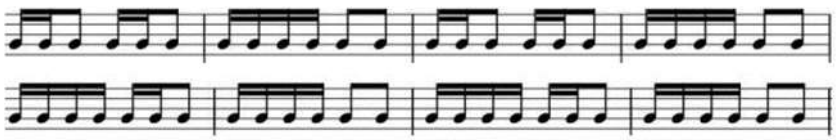

Figure 3. Staff Notation Symbols of the Drum (*bibiliku*) Rhythm

Figure 3 represents a formal translation of Figure 1 into the international musical language of staff notation. All information presented in Figure 1 is converted into musical symbols without altering the structure, sequence, or duration of the resulting sounds. Each written musical note represents sound A, B, or C according to the corresponding rhythmic sequence. The shape of the note heads and stems reflects the division of time values or sound duration, indicating whether the sound is long, short, or medium. The purpose of this transcription is to make the traditional rhythmic pattern accessible, learnable, and performable by individuals who understand international musical notation, not only by local communities familiar with the A, B, and C symbolic system.

In this system, each letter represents a different drumming technique that produces a distinct sound character. Sound A refers to the basic or open sound, produced by striking the center of the drumhead with an open palm, resulting in a low, resonant, and echoing tone. This sound functions as the main rhythmic foundation and provides beat stability. Sound B refers to the pressed or closed sound, produced by striking the edge of the drumhead or immediately damping the sound after striking, resulting in a short, dry, and relatively higher-pitched tone. This sound serves as rhythmic variation and accentuation to avoid monotony. Meanwhile, sound C refers to the marking or closing sound, produced by a stronger and more emphatic strike on a specific part of the drum, producing a clear and firm tone that signals the end of a rhythmic cycle before the pattern is repeated or changed.

Table 1. Standard Pattern and Number of Beats

Standard Pattern	Beat	Pattern
A-A-B-C-A-A-B-C	the first 8 beats	I
B-A-B-C-B-A-B-C	the second 8 beats	II
A-A-B-C-A-A-B-C	the third 8 beats	I
B-A-B-C-B-A-B-C	the fourth 8 beats	II
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Table 1 represents the structure of the basic rhythm pattern (*standard pattern*) of the *tabere* rhythm shown in Figure 1 and Figure 3, which is performed within one complete cycle. One cycle consists of 16 beats divided into two pattern sections, namely Pattern I and Pattern II.

Pattern I consists of the first 8 beats with the sequence A-A-B-C. This pattern indicates two stable basic sounds, followed by one pressed sound as variation, and ends with a marking sound. This pattern functions as the main rhythmic structure that provides stability within the performance cycle. Meanwhile, Pattern II consists of the second 8 beats with the sequence B-A-B-C. This pattern begins

with a pressed sound as variation, followed by a basic sound, another variation, and ends with a marking sound. This pattern serves as a rhythmic development or variation to ensure that the performance remains dynamic and non-monotonous when repeated in the context of the dance performance.

Based on Table 1, it can be analyzed that an arithmetic sequence pattern emerges from the *tabere* rhythm performed on the bibiliku drum. When Pattern I and Pattern II are played repeatedly and regularly within a performance cycle, a periodic sequence is formed, namely $I - II - I - II - I - II - \cdots$. This repetitive structure indicates a regular rhythmic organization with periodic characteristics, which can be represented as a mathematical pattern within the context of ethnomathematics. If I is represented as 1 and II as 2, then the resulting sequence is $1 - 2 - 1 - 2 - 1 - 2 - \cdots$. This pattern indicates a periodic rhythmic regularity within the structural organization of the traditional musical performance.

It should be noted that the sequence $1 - 2 - 1 - 2 - 1 - 2 - \cdots$ is a periodic (repeating) sequence, rather than an arithmetic or geometric sequence. Its main characteristics are: a) The values repeat regularly every 2 terms (period 2); b) It does not have a constant difference, so it is not an arithmetic sequence; and c) It does not have a constant ratio, so it is not a geometric sequence.

Mathematically, it can be expressed as:

$$a_n = \begin{cases} 1, & \text{if } n \text{ is odd} \\ 2, & \text{if } n \text{ is even} \end{cases}$$

Upon further analysis, it is found that Pattern I consistently occurs at odd-indexed terms, forming the sequence $1, 3, 5, 7, ...$, while Pattern II consistently occurs at even-indexed terms, forming the sequence $2, 4, 6, 8, ...$ Both sequences are arithmetic sequences with a common difference of 2.

Sequence $1, 3, 5, 7, ...$ is an arithmetic sequence with:

First term (a) = 1

Common difference (d) = 2

The general formula for the nth term of an arithmetic sequence is:

$$U_n = a + (n - 1)d$$

$$\text{Substituting a} = 1 \text{ and d} = 2\text{:}$$

$$U_n = 1 + (n - 1)(2) = 2n - 1$$

Thus, the general formula for the *n*-th term of the odd-beat pattern is:

$$U_n = 2n - 1 \quad (1)$$

Sequence $2, 4, 6, 8, ...$ is an arithmetic sequence with:

First term (b) = 2

Common difference (d) = 2

The general formula for the *m*-th term of an arithmetic sequence is:

$$V_m = b + (m - 1)d$$

$$\text{Substituting b} = 2 \text{ and d} = 2:$$

$$V_m = 2 + (m-1)2 = 2m \quad (2)$$

Discussion

Based on the results of the study presented, it was found that the *Tae Tabere* rhythm performed on the bibiliku musical instrument in the Likurai dance is not merely a traditional sequence of sounds, but also possesses a strong structural, cultural, and mathematical foundation. In this study, it was revealed that the simple notation system consisting of the letters A, B, and C used in the transcription of rhythmic patterns carries clear technical and functional meanings within the cultural practices of the Malaka community in Kabupaten Malaka. Each letter represents a different striking technique and sound character:

1. Letter A represents an open/basic sound that functions as the rhythmic foundation and maintains beat stability, produced by striking the center of the drumhead.
2. Letter B represents a pressed/closed sound that provides variation and accent to avoid monotony, produced by striking the edge of the drumhead or damping the sound immediately after striking.
3. Letter C represents a marking/closing sound that signals the end of a rhythmic cycle before the pattern is repeated or changed, characterized by a firm and strong tone.

The rhythmic pattern is structured into one complete cycle of 16 beats, divided into two main sections: Pattern I (A-A-B-C-A-A-B-C) in the first 8 beats and Pattern II (B-A-B-C-B-A-B-C) in the second 8 beats. This sequence is not randomly formed but is intentionally designed to create an organized, dynamic performance flow that aligns with the movements of the Likurai dance, which historically functioned as a welcoming dance for returning warriors. Its meaning extends beyond sound alone, as the rhythmic structure reflects values of order, unity, and collective spirit, where the regularity of beats symbolizes communal solidarity in celebrating victory.

Furthermore, the name of the bibiliku musical instrument itself carries deep cultural meaning. Derived from the Tetun language, *bibi* means goat and *haliku/liku* means to hold or clamp under the arm. This reflects the local knowledge system in selecting materials (goat skin) and in designing the playing technique adapted to the instrument's physical form and performance needs, demonstrating that every element in this traditional musical practice is interrelated in both meaning and function.

From a mathematical perspective, the *Tae Tabere* rhythm pattern demonstrates clear structures of periodicity and sequential symmetry as a fundamental concepts in mathematics, particularly within the theory of sequences and series.

Concept of Periodicity: The rhythmic cycle is formed through the regular alternation and repetition of Pattern I and Pattern II: $I - II - I - II - I - II -$ .... This sequence is periodic, meaning the same pattern recurs regularly every two segments. If we symbolize Pattern I as 1 and Pattern II as 2, the resulting sequence becomes $1 - 2 - 1 - 2 - 1 - 2 -$ ..., which has a period of 2. Mathematically, this pattern can be expressed as a piecewise function:

Here, Pattern I consistently appears at odd-numbered positions $(1, 3, 5, 7, \dots)$, forming an arithmetic sequence with a first term of 1 and a common difference of 2, following the formula for the n-th term: $U_n = 2n - 1$. In contrast, Pattern II appears at even-numbered positions $(2, 4, 6, 8, \dots)$, also forming an arithmetic sequence with a first term of 2 and a common difference of 2, following the formula for the m-th term: $V_m = 2m$. This confirms that a strict mathematical regularity underlies the composition of the rhythm.

Concept of Symmetry: This is evident in the structure of each pattern, where a specific sequence of sounds is repeated within a single group of 8 beats. In Pattern I, the sequence A-A-B-C is repeated twice; likewise, in Pattern II, the sequence B-A-B-C is repeated twice. This repetition of identical sequences within one block of beats creates balance and symmetry in the sound, resulting in a rhythm that sounds harmonious and easy for dancers to follow.

Most importantly, this mathematical structure was not imposed from outside; rather, it is inherently embedded within the Malaka community's cultural practices. Without any formal knowledge of sequence formulas or the concept of periodicity, the local people have developed a rhythmic system that fully aligns with these mathematical principles, enabling them to create performances that are both aesthetically pleasing and structurally orderly.

These research findings hold significant and positive implications for the field of education, particularly in the development of local culture-based mathematics instruction or the ethnomathematics approach. Its practical applications are outlined below:

Learning the Concepts of Sequences and Series: Topics such as arithmetic sequences, periodic sequences, and the formula for the n-th term, which students often perceive as abstract, can be presented in a concrete manner through the rhythmic patterns of the *Bibiliku*. Students can observe the alternating sequence of Pattern I and Pattern II, construct the numerical pattern 1–2–1–2, and then formulate its mathematical relationships based on elements from their own culture. This approach makes learning more meaningful and relevant.

Integrated Learning of Mathematics and Cultural Arts: This study bridges the subjects of Mathematics and Cultural Arts. Teachers can guide students in learning how to perform the rhythm, record patterns using the A-B-C notation system, and then convert these into numerical patterns or standard musical

notation. Simultaneously, they can explain concepts such as time division, duration, and symmetry. This aligns perfectly with curriculum requirements that emphasize integrated and contextual learning.

Cultural Preservation Throught Education: By incorporating this material into the curriculum, schools play an active role in preserving the *Likurai* dance and the *Bibiliku* musical instrument. Students not only learn mathematics but also gain an understanding of the history, meaning, and wisdom of their ancestors in organizing order and patterns.

Developing Logical and Analytical Thinking: Through analyzing rhythmic patterns, students are trained to recognize regularities, predict subsequent sequences, and formulate simple formulas, all of which are fundamental abilities in mathematical and scientific reasoning.

From an ethnomathematics perspective, these findings confirm a key fact: traditional communities in Malaka have naturally applied mathematical concepts in their daily lives and cultural practices, even without using formal mathematical terms or formulas. For centuries, the people of Malaka have employed principles that lie at the very core of mathematics: repetition, regularity, division, and sequence, in composing the rhythms of the Bibiliku. Concepts such as periodicity, symmetry, and arithmetic sequences, which are formally taught in schools, have long been applied practically and systematically by the community to create rhythms that align with both the movements of the dance and their cultural meanings.

This demonstrates that mathematics is not an external or alien body of knowledge; rather, it has grown and evolved alongside human culture. Local knowledge concerning how to organize sounds, group beats, and repeat patterns represents another form of mathematics, passed down orally and through practice from one generation to the next. The ethnomathematics approach adopted in this study helps elevate and recognize the value of this knowledge, while also highlighting that culture itself is a rich and valuable source of mathematical concepts, one that deserves to be studied and further developed.

The identification of sequence-based patterns within *bibiliku* rhythms aligns with the findings documented by Hijriati et al. (2026). Furthermore, the present study offers a mathematical interpretation demonstrating that the rhythmic structures performed on the *bibiliku* in the *Likurai* dance reflect a profound interconnection between mathematical principles and cultural functions. This outcome corroborates research by Novitasari et al. (2022), Rosadi et al. (2024), Lubis et al. (2024), and Siregar et al. (2024), who collectively affirm that cultural functions are inherently embedded within mathematical concepts and their educational applications.

This study is limited to the analysis of the *tae tabere* rhythm. In the practice of Likurai dance performances, there are several other types of rhythms with different functions whose mathematical structures have not yet been identified. In addition, variations in rhythmic patterns and nuances across

different groups and regions have not been examined, so the full richness of the mathematical structures within the entire Bibiliku musical repertoire has not yet been comprehensively described.

Conclusion

This study found that the rhythmic patterns of *bibiliku* beats in the Likurai dance in Umatoos Village, Malaka Regency, East Nusa Tenggara Province form an arithmetic sequence with a common difference of 2. Based on the research findings and discussion, it can be concluded that the *Tae Tabere* rhythm pattern performed on the *Bibiliku* instrument in the *Likurai* dance of the Malaka community, East Nusa Tenggara, constitutes a structured musical system using the symbols A, B, and C, each representing a distinct function: as a rhythmic foundation, a variation, and a cycle marker respectively. Composed of two sections that repeat in a regular sequence, this pattern embodies the community's values of order, unity, and historical spirit. Mathematically, the rhythm demonstrates concepts of periodicity and sequential symmetry, forming a repeating pattern that can be represented as a numerical sequence, where each section corresponds to an arithmetic sequence with a constant difference. These findings confirm that mathematical concepts such as sequence, repetition, and regularity are inherently present in cultural practice through traditional music; as such, this rhythm holds great potential as a contextual learning resource within an ethnomathematics approach, integrating mathematics and culture while contributing to the preservation of local wisdom. Nevertheless, this study is limited to the analysis of only one type of rhythm, and therefore does not cover the variations and mathematical structures found in other rhythm patterns within the broader *bibiliku* musical tradition.

Recommendation

Based on the findings of this study, it is recommended that future researchers expand the scope of investigation by analyzing various other rhythm patterns found in *Bibiliku* performances, as well as in other traditional musical instruments across East Nusa Tenggara. Further research should also examine the diverse mathematical structures and philosophical meanings embedded within these cultural expressions. In the field of education, the *Tae Tabere* rhythm pattern and its mathematical analysis can be utilized as contextual teaching material for topics such as sequences and series, number patterns, and symmetry. It may also be developed into an integrated learning module combining mathematics and cultural arts that is rooted in local wisdom, thereby making learning more meaningful and fostering students' appreciation of their own culture. Meanwhile, for cultural preservationists and the wider community, the results of this study can serve as scientific documentation that reinforces the value of the *Likurai* dance and the *Bibiliku* instrument as cultural heritage, one that possesses artistic beauty as well as a systematic structure of knowledge. Furthermore, these findings should encourage continuous efforts to pass down this knowledge, both through direct practice and educational media, ensuring that it endures and is not lost amid the changes of time.

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