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Learning Set Theory from Traditional Dance: Ethnomathematics Exploration in Bimanese Traditional Dance *Wura Bongi Monca*

Khairullah[1], Rully Charitas Indra Prahmana[1,2], Monica Arnal-Palacián[2,3]

[1]Mathematics Education Department, Universitas Ahmad Dahlan, Yogyakarta, Indonesia
[2]Ethno-Reaslistic Mathematics Education Research Center, Universitas Ahmad Dahlan, Yogyakarta, Indonesia
[3]Mathematics Education Department, University of Zaragoza, Zaragoza, Spain
E-mail: rully.indra@mpmat.uad.ac.id

Abstract

Mathematics, often viewed as abstract and detached from everyday life, has deep historical roots intertwined with societal phenomena. This study explores initiatives to connect mathematics with Indonesian cultural realities and perceptions. Specifically, it investigates uncovering historical values and mathematical set concepts embedded within the Wura Bongi Monca dance. Utilizing a qualitative approach with ethnographic methods, data were gathered through observations, literature reviews, and interviews with cultural experts and enthusiasts. The findings illustrate that the Wura Bongi Monca dance embodies set concepts in its movements, reflecting local wisdom values. These values are not only perceived but also contemplated and applied in daily life, enriching community understanding of mathematics and introducing a cultural dimension to mathematics education in schools. This research introduces a new perspective on integrating mathematics with local culture, suggesting it as a transformative approach to enhance the symbiotic relationship between mathematics and culture.

Keywords: Ethnography, Ethnomathematics, Indonesian Traditional Dance, Set Theory, Wura Bongi Monca Dance

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Introduction

Indonesia's rich cultural tapestry is internationally celebrated, particularly through its diverse array of traditional dances that serve as profound expressions of regional identities (Prabowo et al., 2022; Wang & Liu, 2020). These dances evolve within distinct local contexts, imbuing deep philosophical meanings that shape community identities and cultural heritage (Georgios, 2018; Juwariyah & Abida, 2023). However, contemporary trends reveal a concerning decline in interest among younger generations in these cultural practices, exacerbated by their limited integration into formal educational curricula (Daryanti & Jazuli, 2019). Moreover, rapid modernization poses a significant threat to the philosophical foundations embedded in these traditions (Rosala & Budiman, 2020). Addressing these challenges is pivotal for safeguarding the historical and cultural significance of traditional dances, particularly their potential to enrich and integrate into contemporary education systems.

One exemplary case is the *Bimanese Wura Bongi Monca* dance from West Nusa Tenggara, esteemed for its ceremonial role within Bima community traditions (Geofany et al., 2022). Typically performed by groups of four to six young girls, this dance symbolizes themes of prosperity and nobility through its intricate ritual movements and symbolic gestures (Budasi et al., 2022; Ikhwan & Pamungkas, 2023). Its cultural significance extends as an emblem of hospitality and tradition during royal ceremonies,

embodying the essence of Bima identity (Aryanti, 2023). The potential loss of such cultural practices not only risks erasing their embedded historical values but also underscores the urgency of preserving and revitalizing these traditions.

Ethnomathematics presents a promising approach to integrating cultural heritage into mathematics education (Rosa et al., 2016). Defined as the study of mathematical practices within specific cultural contexts, ethnomathematics facilitates the exploration of mathematical concepts through cultural symbols, principles, and skills (D'Ambrosio, 2016). Previous studies, such as those investigating Javanese *Wayang Kulit* performances, have successfully linked fundamental set theory concepts to the arrangement of characters (Prahmana & Istiandaru, 2021). This approach not only enhances students' mathematical understanding but also fosters a deeper appreciation for cultural diversity and relevance in education. Renewed research focusing on the historical values and mathematical concepts embedded within the *Bimanese Wura Bongi Monca* dance holds promise for advancing ethnomathematical explorations within Indonesian cultural contexts, fostering collaborations with institutions like the Pasole Sila dance studio and the Bima Sultanate Palace.

In light of these considerations, this study aims to explore the integration of the *Bimanese Wura Bongi Monca* dance into mathematics education, investigating how this traditional cultural practice can enhance students' mathematical learning experiences. Specifically, the research question guiding this study is: How does incorporating the mathematical concepts and cultural values of the *Bimanese Wura Bongi Monca* dance contribute to the educational outcomes of students in mathematics education?

Methods

The type of research utilized in this study is qualitative research. Qualitative research involves using descriptive methods or data to analyze a particular problem or phenomenon based on the views or perceptions of an individual or group (Fossey et al., 2002). The data in this study are derived from real occurrences in the field, managed in the form of words, images, or interview recordings.

Specifically, this study employs a qualitative research approach with an ethnographic methodology. This approach is used to investigate the culture within a particular community or group (Grossoehme, 2014). The ethnographic approach chosen for this research aims to explore ethnomathematics in the traditional *Bimanese Wura Bongi Monca* dance. The descriptions in this study are intended to uncover the historical values and set theory concepts within the traditional *Bimanese Wura Bongi Monca* dance. The descriptive process involves detailing the results of observations, documentation, and interviews with informants. Furthermore, the descriptive process will be analyzed by the researcher to examine the historical values in the movements of the traditional *Bimanese Wura Bongi Monca* dance, specifically the

creative dance from the Pasole Sila studio and the original from the Bima Sultanate, and their relation to set theory concepts.

Finally, two research subjects were selected based on their willingness and capability as Bima culturalists: one served as an observer of the *Wura Bongi Monca* dance at the Bima Sultanate Palace (N1), and the other is the general chairman and sole trainer of the *Wura Bongi Monca* dance community at the Pasole Sila studio (N2). The study involved key informants including the chairman and sole trainer of the Pasole Sila Bima NTB studio, as well as cultural observers. The research is focused on investigating the historical values associated with the traditional *Bimanese Wura Bongi Monca* dance and its connection to mathematical concepts in set theory.

Results and Discussions

The movements in the *Bimanese Wura Bongi Monca* dance from the Pasole Sila studio and the Bima Sultanate contain historical values and mathematical concepts that can be implemented in teaching, particularly in set theory concepts such as the empty set, universal set, disjoint sets, set cardinality, subsets, power sets, intersections, unions, complements, and differences.

Historical Values of the *Bimanese Wura Bongi Monca* Dance

The researcher categorizes the development of the *Bimanese Wura Bongi Monca* dance based on the findings, as illustrated in Figure 1.

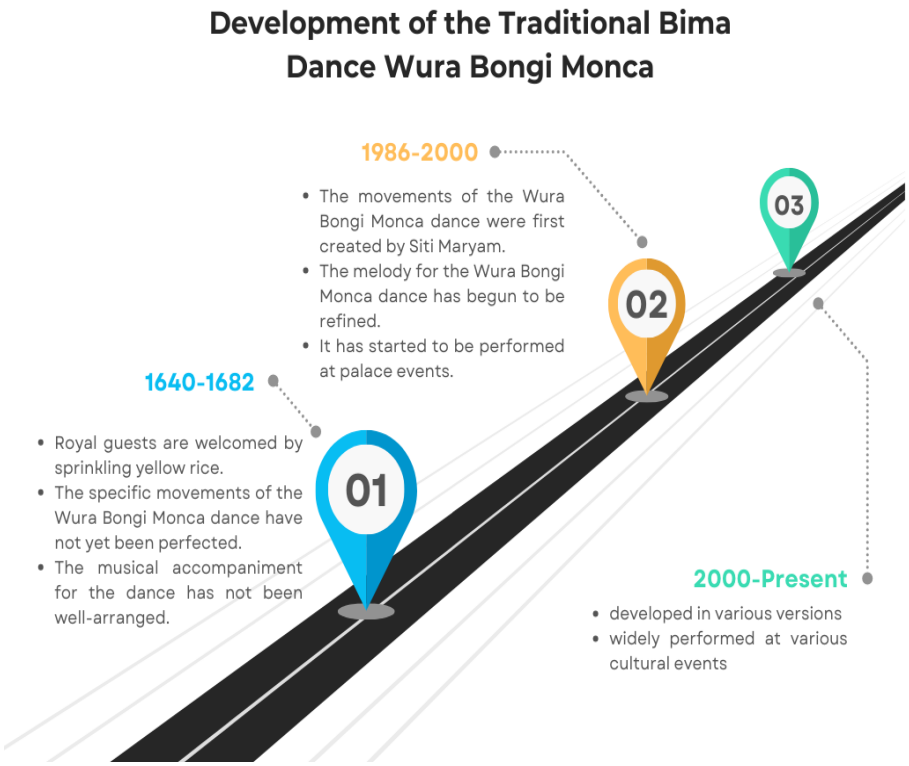

Figure 1. Development of the traditional *Bimanese Wura Bongi Monca*

The *Bimanese Wura Bongi Monca* dance dates back to the reign of Sultan Abdul Kahir Sirajuddin, around 1640-1682. However, during that period, the dance had not yet been perfected. It featured simple movements, and the accompanying music had not yet been refined to achieve harmonious melodies. This information was conveyed by an informant during an interview session, highlighting the dance's historical roots and its subsequent development into the sophisticated performance art it is today.

"...The Wura Bongi Monca dance originated from the Sultanate of Abdul Kahir Sirajuddin between 1640-1682 as part of the tradition of welcoming guests by scattering rice. At that time, this dance did not yet have perfected movements and musical accompaniment..." (Informant N1).

Over time, this tradition began to evolve, and in 1986, it was developed and widely introduced by Siti Maryam Salahuddin under the name *Wura Bongi Monca* dance. In 1986, graceful and elegant movements were crafted to highlight the gentle demeanor of Bima girls while dancing. This was also expressed by a Bima cultural expert during an interview session, stating that.

"...The Wura Bongi Monca dance was created in 1986 by Siti Maryam (Ruma Ina Kau Mari), the daughter of Sultan Salahuddin. In collaboration with Mrs. Linda, who perfected its musical accompaniment, they were inspired to create a welcoming dance involving the scattering of yellow rice, which then became known as the Wura Bongi Monca dance..."

Since then, in the 2000s, the *Wura Bongi Monca* dance has become a tradition and has been creatively adapted in various regions of Bima, with different movements in each art studio. This was also conveyed by informant N2 during an interview session, stating that:

"...Created by Siti Maryam in 1986. Since then, until the 2000s, this dance has been performed in numerous versions. The first group to start showcasing it was the Paju Monca art studio..." (Informant N2)

Varieties of Movements, Number of Dancers, Costume Forms, Accompanying Music, and Musical Instruments

The *Wura Bongi Monca* dance features a variety of beautiful movements, explored through two versions: the original movements from the Bima Sultanate Palace and the creative interpretations by the Pasole Sila Art Studio. Their explanations are displayed in Table 1.

In Table 1, the differences in the *Wura Bongi Monca* dance based on versions from the Bima Sultanate and the Pasole Sila Art Studio are explained, including varieties of movements, number of dancers, costume forms, accompanying music, and musical instrument.

Table 1. Variety of movements, number of dancers, costume forms, accompanying music, and musical instruments in the *Wura Bongi Monca* dance

Aspect	***Wura Bongi Monca* dance: Sultanate version**	***Wura Bongi Monca* dance: Various art studio creations Pasole Sila**
Variety of Movements	1. Initial movements include *lampa luu* and *nemba*. 2. Core movements consist of *lele kui*, *lele wana*, and *paleo*. 3. Closing movements comprise *nemba* and *lampa losa*	1. The initial movements consist of *Nemba*, *tau bongi di mangko*, *pata angi*, and *lenggo doho*. 2. The core movements comprise *lao weha ao bunti*, *lenggo doho*, and *wura bongi*. 3. The closing movements consist of the *bunga satako* and *nemba* movements.
Number of Dancers	The original number of dancers in the *Wura Bongi Monca* dance from the Bima Sultanate, perfected by Ibu Siti Maryam, is between 6 to 12 and must not be odd.	The number of dancers in the *Wura Bongi Monca* dance from the Pasole Sila art studio creation consists of 6 teenage female dancers and 1 male dancer serving as a guardian to attend to guests.
Costumes	*baju bodo* and *tembe salungka*	*baju bodo* and *tembe salungka*
Accompanying Music	*genda mbojo* or *silu*	*genda mbojo* or *sarone*
Musical Instruments	two *gendang*, *gong*, *katongga besi*, and *sarone*	*tawa-tawa*, *gong*, *sarone*, and big *gendang*

Aside from the variety of movements, costumes, and accompanying music, it turns out there are philosophical values and implicit meanings in the *Wura Bongi Monca* dance. As revealed by both research informants, these are detailed in Table 2.

Table 2. Historical values in the *Wura Bongi Monca* dance

No	Terminology	Philosophical Meanings
1	*Wura Bongi Monca* (Scattering yellow rice)	The *Wura Bongi Monca*, in Bahasa Indonesia, can be interpreted as "Scattering yellow rice," symbolizing the blessings and fertility of the Bima land, the prosperity of the Bima society, and the honor bestowed upon guests. It teaches respect for guests and emphasizes the importance of maintaining bonds as per Islamic teachings. It imparts the values of welcoming guests with dignity and offering prayers for their happiness and safety. This message is also reflected in the color yellow, symbolizing glory.
2	*Nemba* (Greeting), *tau bongi di mangko* (placing rice in a container) and *pata angi* (fostering relationships/getting)	*Nemba* in English means respect/greeting, *Tau bongi di mangko* means placing rice in a container, *pata angi* means fostering relationships/getting acquainted. Overall, the initial movements signify upholding the value of honor and consistently nurturing social bonds among people.
3	*Kawoha* movements (Move the core)	It demonstrates the gentle and hospitable nature of the Bima community or Bima girls welcoming honored guests from outside the region and considering those guests as highly noble.
4	*Kakento* movements (Final move)	It showcases the gentleness of the Bima community towards the general public or the common people and bestows the highest honor upon them.

5	*Bajo Bodo* (traditional clothing of Bima)	The *bado* attire, which is the traditional clothing of Bima worn by *Wura Bongi Monca* dancers, carries implicit significance, providing uniformity, cohesion, and harmony during the dance performance, ensuring that the audience is entertained and captivated by their appearance.

The Concept of Sets in the *Wura Bongi Monca*

Universal Set

In the *Wura Bongi Monca dance*, there are various movements, including the original movements from the Bima Sultanate Palace and creative movements from various art studios, specifically the Pasole Sila Art Studio, illustrated in Figure 2. From several observations, the author found that the variety of movements in the *Wura Bongi Monca* dance can be considered a concept in mathematics known as the Universal Set.

Figure 2. Illustration of the universal set

S1 = Universal Set of Movements in the Wura Bongi Monca Dance created by the Pasole Sila Art Studio

= {Initial Nemba, Tau Bongi Monca, Pata Angi, Lenggo Doho, Lao Weha Ao Bunti, Lenggo Kidi, Wura Bongi, Bunga Satako, Final Nemba}.

Mathematically, it can be written as.

$$S1 = \{x \mid x \text{ is Movements in the Wura Bongi Monca Dance created by the Pasole Sila Art Studio}\}$$

Furthermore, Figure 3 shows several movements in the *Wura Bongi Monca Dance* created by the Pasole Sila Art Studio. These movements can be constructed as universal set in learning set theory.

Figure 3. Illustration of the Universal Set of Movements in the *Wura Bongi Monca* Dance created by the Pasole Sila Art Studio

S2 = Universal Set of Movements in the Original Wura Bongi Monca Dance from the Bima Sultanate

= {Lampa luu, Nemba, Lele Wana, Lele Kui, Lele Bali Bae, Paleo, Lampa Losa}

Mathematically, it can be written as

$$S2 = \{y \mid y \text{ is a member of movements Wura Bongi Monca dance from Bima Sultanate}\}$$

Furthermore, Figure 4 shows several movements in the *Wura Bongi Monca* Dance from the Bima Sultanate. These movements can be constructed as another universal set in learning set theory.

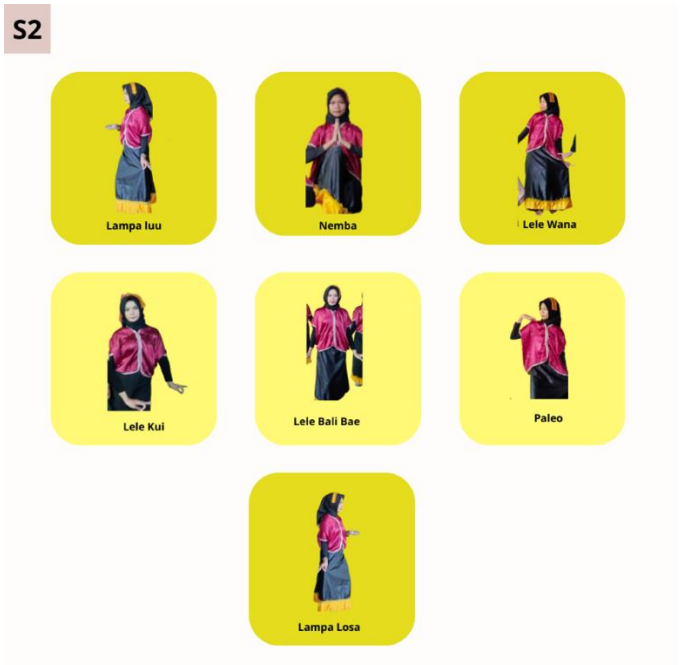

Figure 4. Illustration of the Universal Set of Movements *Wura Bongi Monca* Dance from the Bima Sultanate

Next, the researcher created several examples sets based on observational study results, including Sets A, B, C, D, and F. Set A consists of Initial *Nemba, Tau Bongi Monca, Pata Angi*, and *Lenggo Doho*, as shown in Figure 5. Mathematically, it can be written as:

$$A = \{ x \in S1 \mid x \text{ is a member of the initial movements in the Pasole Sila Art Studio's Creation} \}$$

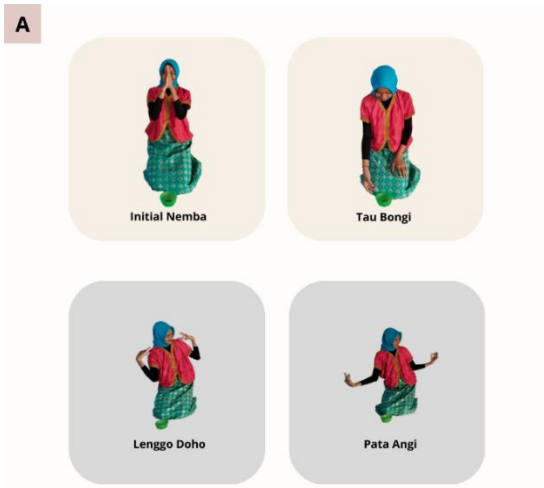

Figure 5. Illustration of Set A: Initial Movements Created by the Pasole Sila Art Studio

Furthermore, Set B consists of *Lao Weha Ao Bunti, Lenggo Kidi,* and *Wura Bongi* illustrated in Figure 6. Mathematically, it can be written as:

$$B = \{ y \in S1 \mid y \text{ is a member of the core Movements Created by the Pasole Sila Art Studio} \}$$

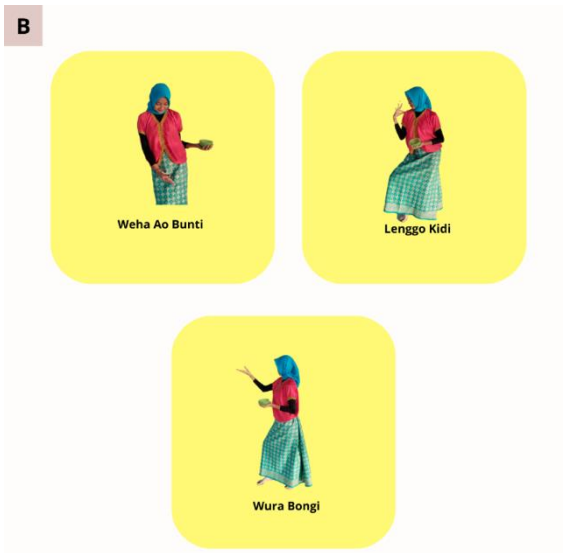

Figure 6. Illustration of Set B: Core Movements Created by the Pasole Sila Art Studio

Set C consists of *Final Nemba* and *Bunga Satako* as shown in Figure 7. Mathematically, it can be written as,

$$C = \{ x \in S1 \mid x \text{ is a member of the closing movements created by the Pasole Sila studio} \}$$

Figure 7. Illustration of Set C: Closing Movements Created by the Pasole Sila Art Studio

Set D consists of *Lampa luu* and *Nemba* as shown in Figure 8. Mathematically, it can be written as,

$$D = \{x \in S2 \mid x \text{ is a member of the initial movements from the Bima Sultanate}\}$$

Figure 8. Illustration of Set D: Initial Movements from the Bima Sultanate

Set E consists of *Lele Wana, Lele Kui, Lele Bali Bae*, and *Paleo* as shown in Figure 9. Mathematically, it can be written as,

$$E = \{x \in S2 \mid x \text{ is a member of the core movements from the Bima Sultanate}\}$$

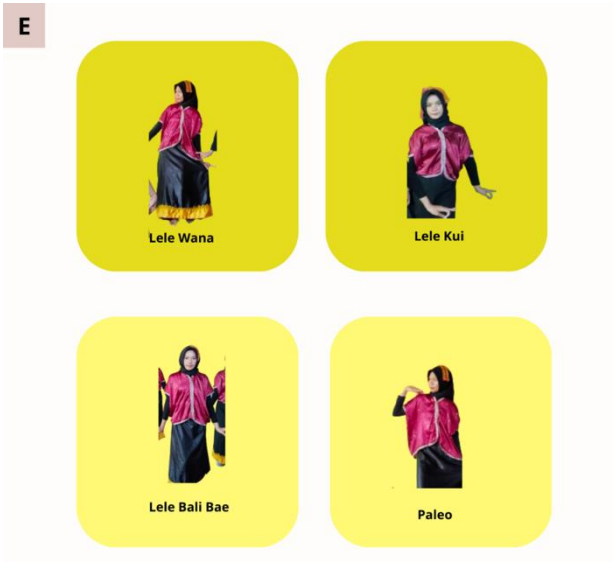

Figure 9. Illustration of Set E: Core Movements from the Bima Sultanate

Set F consists of *Nemba* and *Lampa Losa* as shown in Figure 10. Mathematically, it can be written as,

$$F = \{x \in S2 \mid x \text{ is a member of the closing Movements from the Bima Sultanate}\}$$

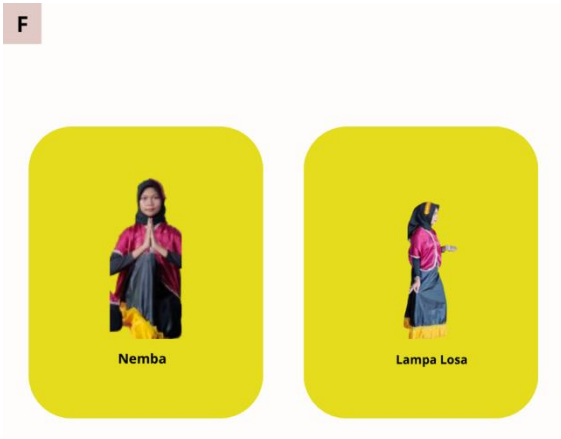

Figure 10. Illustration of Set E: Closing Movements from the Bima Sultanate

Disjoint Sets

The *Wura Bongi Monca* dance also features the concept of disjoint sets. In this case, A // C means sets A and C are disjoint because both sets are not empty and do not have any elements in common, illustrated in Figure 11.

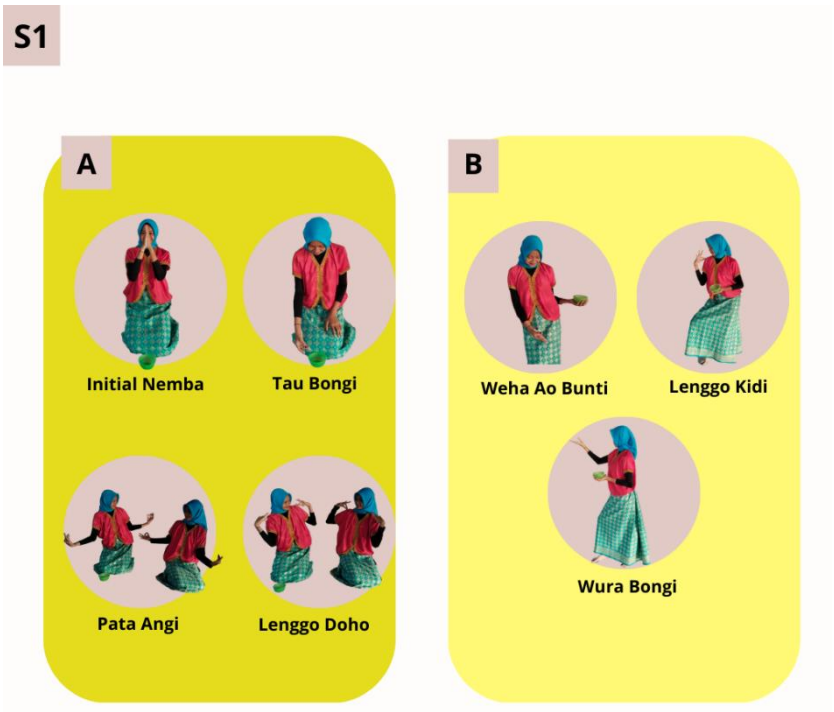

Figure 11. Illustration of Disjoint Sets

Sets A and B are disjoint because they are not empty and do not have any common elements. **A** = {*Initial Nemba, Tau Bongi Monca, Pata Angi, Lenggo Doho*}, while **B** = {*Lao Weha Ao Bunti, Lenggo Kidi,*

Wura Bongi}

Cardinality of Sets

The *Wura Bongi Monca* dance also introduces the concept of set cardinality (Figure 12), as follows,

A={ X ∈ S1 | X is a member of the initial movements}.

A = {*Initial Nemba, Tau Bongi Monca, Pata Angi, Lenggo Doho*}

n(A) = 4

Which is read as the cardinality of set A is 4.

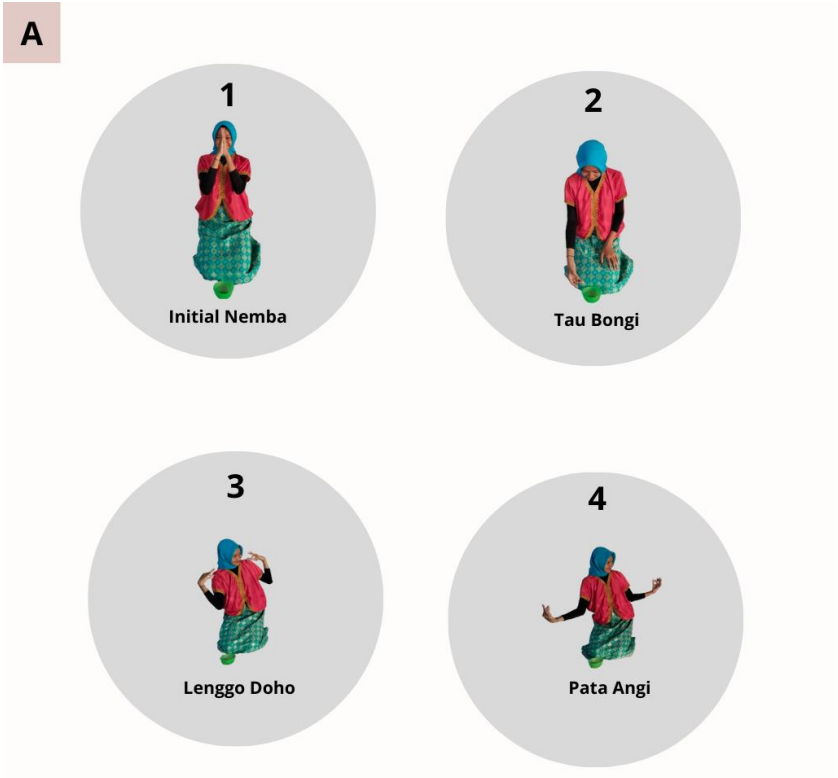

Figure 12. Cardinality of Sets

Subset

The *Wura Bongi Monca* dance also includes the concept of subsets, as shown in Figure 13. In this case, A ⊄ C is read as A is not a subset of C, because each member of A is not a member of C. Meanwhile, A ⊂ S1 is read as A is a subset of S1, because each member of A is a member of the universal set S1. For example, a subset of the Closing movements is,

1. **{}** ⊂ C,
2. **{***Initial Nemba***}** ⊂ C,
3. **{***Bunga Satako***}** ⊂ C,
4. **{***Final Nemba, Bunga Satako*} ⊂ C

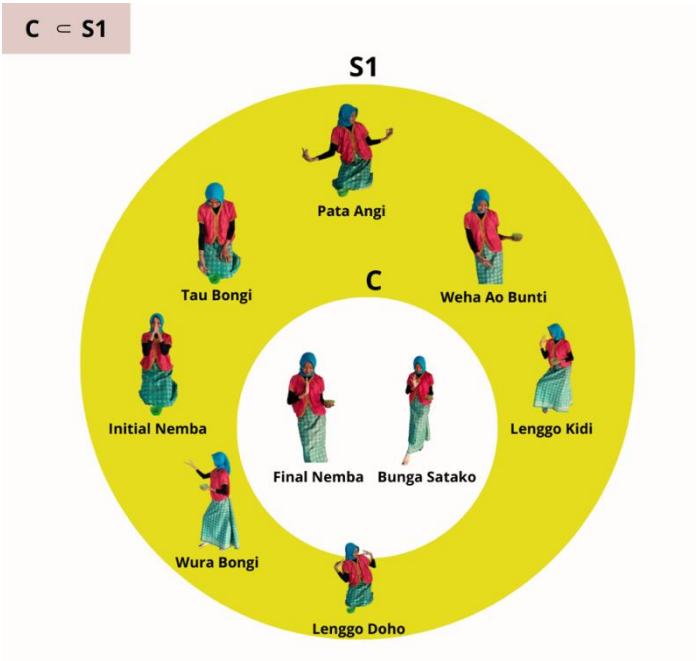

Figure 13. Subset

Power Set

In the *Wura Bongi Monca* dance, there is also the concept of the power set as illustrated in Figure 14. In this case, the power set is denoted by the symbol P. The power set of the Closing movements in the universe S2 is {*Nemba, Lampa Losa*}.

$n(F) = 2$, Thus $n(P(F)) = 2^n = 2^2 = 4$. The formula is $n(P(F) = 2^n$

$P(F) = \{\{ \varnothing \}, \{ Nemba \}, \{ Lampa\ Losa \}, \{ Nemba, Lampa\ Losa \}\}$

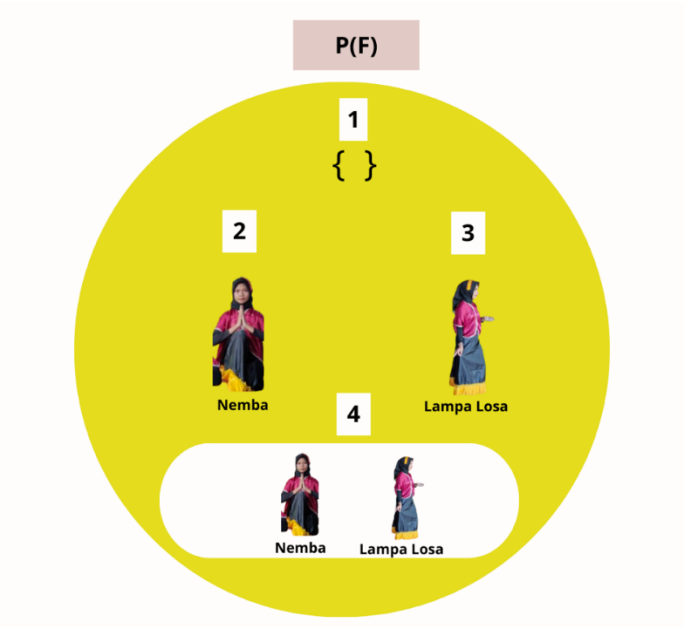

Figure 14. Power Set

Intersection of Sets

The *Wura Bongi Monca* dance includes the concept of intersection as shown in Figure 15. In this case, **D** ∩ **F** is read as **D** intersect **F** which is the *Nemba* Movement. The *Nemba* movement is an element of both sets **D** and **F**.

D= {*Nemba, Lampa luu*}

F= {*Nemba, Lampa Losa*}

D ∩ **F** = {*Nemba*}.

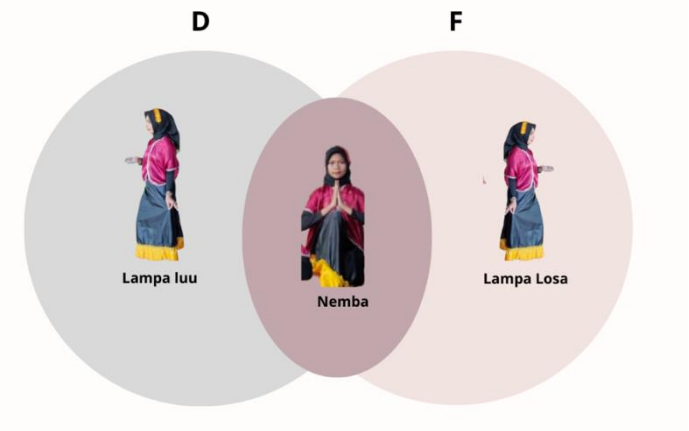

Figure 15. Intersection of Sets

Union of Sets

The *Wura Bongi Monca* dance also includes the concept of the union of two sets as shown in Figure 16. In this case, **E** ∪ **F** = {*Lele Wana, Lele Kui, Lele Bali Bae, Paleo, Nemba, Lampa Losa*} is read as **E** union **F** because the set of members consists of members of E, members of F, or both.

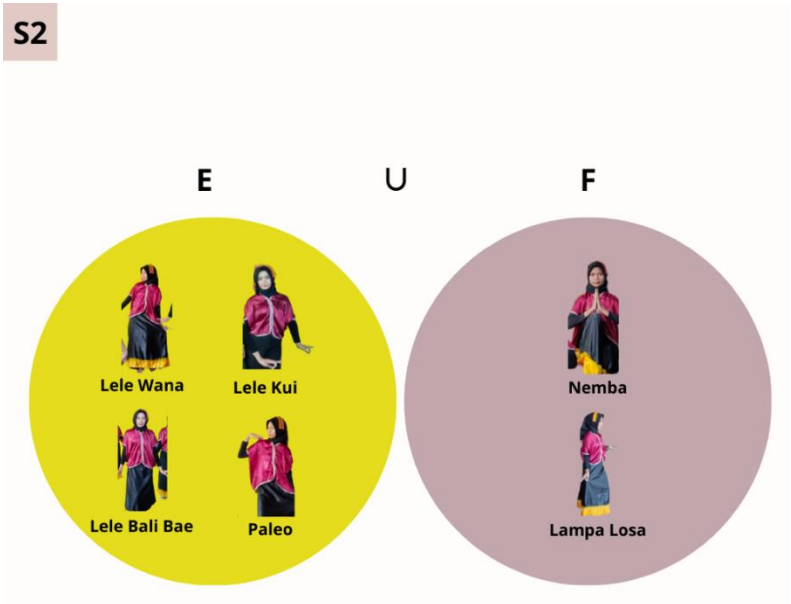

Figure 16. Union of Sets

Complement of a Set

The *Wura Bongi Monca* dance also includes the concept of the complement of a set as illustrated in Figure 17. In this case, for example, the complement set, written as $\mathbf{E}^c$ includes members that are in the universal set but not in set **E.**

S2 = {*Lampa luu, Nemba, Lele Wana, Lele Kui, Lele Bali Bae, Paleo, Lampa Alosa*}

E = {*Lele Wana, Lele Kui, Lele Bali Bae, Paleo*}

Therefore,

$\mathbf{E}^c$ = {*Lampa luu, Nemba, Lampa Alosa*}

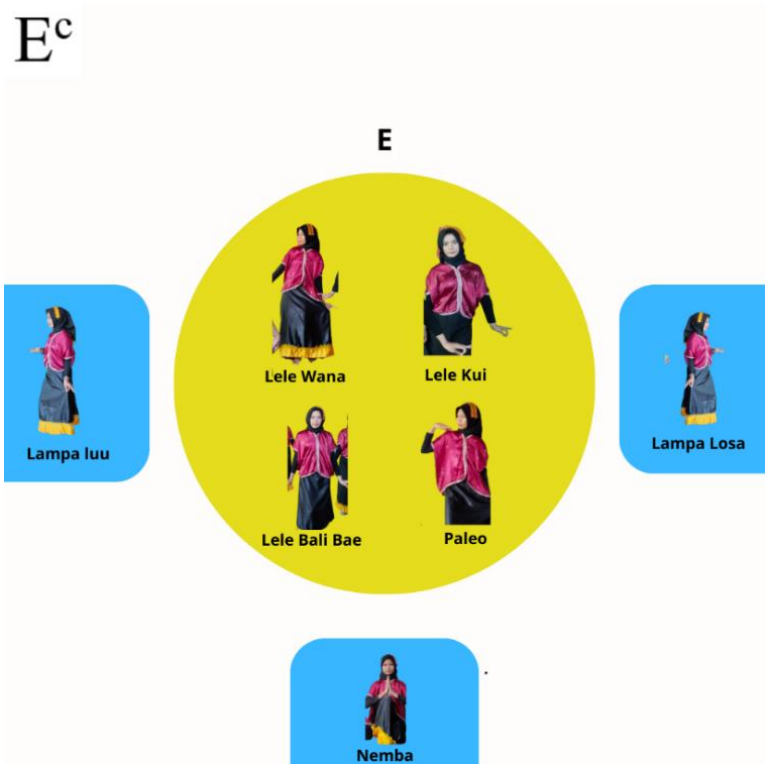

Figure 17. Complement of a Set

Set Difference

The *Wura Bongi Monca* dance also includes the concept of the difference between two sets as shown in Figure 18. In this case, it is **D – F**,

D = {*Nemba, Lampa luu*}

F = {*Nemba, Lampa Losa*}

D – F = {*Lampa luu*}

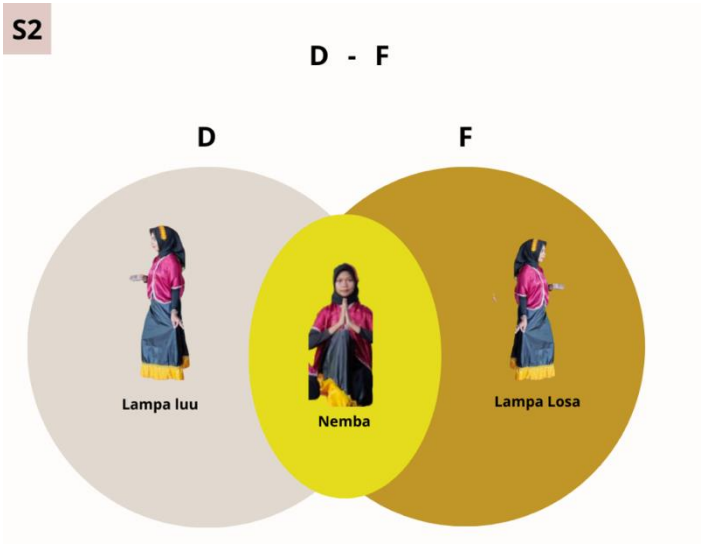

Figure 18. Set Difference

Empty Set

The *Wura Bongi Monca* dance also includes the concept of the empty set as illustrated in Figure 19. If the universal set S1 is intersected with the universal set S2 it is not an empty set because the *Nemba* movement is a member of both S1 and S2. Mathematically, it can be written as follows,

$S1 \cap S2$ because $G_n \in S1$, dan $G_n \in S2$

$G1 = S1 - \{S1 \cap S2\}$

$G2 = S1 - \{S1 \cap S2\}$

$G1 \cap G2 = \emptyset$

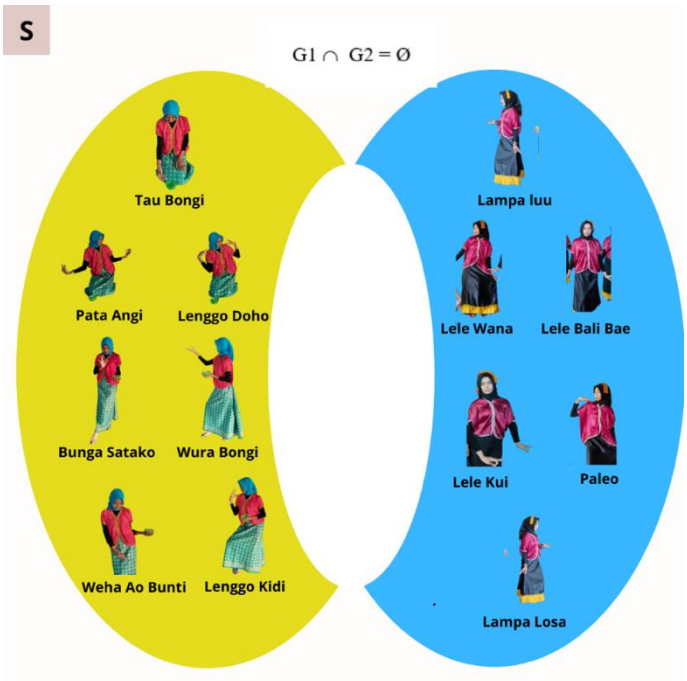

Figure 19. Empty Set

This study delves into the ethnomathematical insights derived from the Bimanese *Wura Bongi Monca dance*, revealing intricate mathematical concepts that are directly applicable to the teaching of set theory. The movement sequences within the dance provide a tangible and culturally rich context for introducing foundational principles in sets, offering a unique perspective on how indigenous cultural practices can enrich mathematical education. By exploring the mathematical underpinnings of the dance, this research contributes to the broader field of ethnomathematics, highlighting the potential of cultural artifacts to serve as effective educational tools.

The findings of this study resonate with existing literature that emphasizes the presence of mathematical elements in diverse cultural contexts (Aikenhead, 2017; Ruef et al., 2020; Orey & Rosa, 2021). Unlike previous studies that have focused on various cultural forms such as Javanese shadow puppets (Prahmana & Istiandaru, 2021), traditional music instruments (Oktaviyani et al., 2023), and educational materials (Subarina et al., 2023), this research extends the application of ethnomathematics specifically to the realm of set theory. By exploring the Bimanese *Wura Bongi Monca* dance, this study offers a novel perspective on integrating cultural artifacts into mathematics education, thereby enriching pedagogical practices with culturally relevant content.

The integration of cultural contexts into mathematics education is crucial for fostering inclusive and engaging learning environments. By acknowledging and incorporating indigenous knowledge systems, educators can enhance students' understanding of mathematical concepts while promoting cultural diversity and respect. The utilization of the Bimanese *Wura Bongi Monca* dance exemplifies how cultural artifacts can serve as effective pedagogical tools, facilitating deeper connections between abstract mathematical concepts and real-world cultural practices.

This study highlights the importance of culturally responsive teaching approaches in mathematics education. By embedding set theory within the cultural context of Bimanese traditions and implementing it through the Ethno-Realistic Mathematics Education approach (Prahmana et al., 2023), educators can potentially enhance not only students' academic performance but also cultivate their respect for cultural diversity. This approach aligns with broader educational objectives aimed at fostering global citizenship and intercultural competence, thereby making mathematics education more meaningful and applicable to students from diverse backgrounds (Prahmana, 2022). Looking ahead, future research should continue to explore the practical implications of integrating ethnomathematical content into educational curricula.

Conclusion

The *Wura Bongi Monca* dance, a traditional cultural expression from Bima, West Nusa Tenggara, created by Siti Maryam in 1986, encapsulates significant ethnomathematical elements. This study reveals

the integration of mathematical concepts, particularly set theory, within the dance movements performed by groups of 4-12 young girls adorned in traditional Bima costumes. Accompanied by traditional Bima instruments, the dance symbolizes the honor of welcoming royal guests and embodies philosophical values such as hospitality, respect, justice, equality, prosperity, and the honoring of guests. The study identifies ten set theory concepts represented in the dance: universal set, empty set, disjoint sets, cardinality of a set, subset, power set, intersection, union, complement of a set, and set difference.

Despite the insightful findings, this study has several limitations. The exploration of ethnomathematics in the *Wura Bongi Monca* dance was confined to specific movements observed from the Bima Sultanate Palace and the Pasole Sila art studio. Consequently, the study's scope was limited to these particular sources, which may not encompass all variations of the dance practiced across different regions and communities. Furthermore, the research primarily focused on the theoretical identification of set concepts, without extensive empirical validation or practical applications in educational settings.

Future research should aim to expand the scope by incorporating a broader range of *Wura Bongi Monca* dance variations from different regions and communities. Additionally, empirical studies should be conducted to validate the theoretical findings and explore the practical applications of integrating ethnomathematics, particularly set theory, in educational contexts. Such studies could investigate the effectiveness of using traditional cultural expressions, like the *Wura Bongi Monca* dance, as pedagogical tools to enhance students' understanding of mathematical concepts and foster a deeper appreciation for their cultural heritage. Moreover, it can serve as a context for implementing the Ethno-Realistic Mathematics Education approach.

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