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Integrating the traditional game of *Bola Bekel* into mathematics education: A culturally relevant context for teaching LCM and GCD

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ABSTRACT

The integration of cultural heritage into mathematics education remains underexplored in the Indonesian educational context, where existing mathematics curricula often overlook the pedagogical potential of local cultural artifacts in contextualizing abstract mathematical concepts. This gap highlights the need for innovative instructional approaches that bridge mathematical understanding with culturally relevant contexts. This study addresses this issue by investigating the mathematical structures embedded in the traditional Indonesian game *Bola Bekel*, with a particular focus on its potential to represent the concepts of Least Common Multiple (LCM) and Greatest Common Divisor (GCD). The primary objective of this research is to explore the historical value of the game and analyze how its inherent mathematical elements can be leveraged to teach LCM and GCD in a more meaningful and contextualized manner. Employing an ethnographic approach, data were collected through visual documentation, direct observation, semi-structured interviews, and literature review. The findings reveal that bola *bekel* not only embodies historical and character-building values but also provides a culturally grounded medium for the representation and understanding of key mathematical concepts. These results underscore the potential of traditional games as effective and contextually rich tools in mathematics instruction. This study contributes to the development of culturally responsive teaching strategies aimed at enhancing students' comprehension and motivation in learning mathematics through the meaningful integration of local cultural heritage.

INTRODUCTION

The teaching of mathematics in Indonesian primary schools remains predominantly rooted in abstract and formal paradigms, often failing to consider students' cultural backgrounds and lived experiences (Sembiring et al., 2008; Revina & Leung, 2021). This disconnect poses a significant challenge, particularly for students from culturally rich communities whose heritage and everyday practices are not systematically integrated into the learning process. Kumar (Kumar et al.,2018) argue that the mismatch between instructional approaches and students' cultural experiences can undermine learning motivation and cognitive engagement.

Within the primary mathematics curriculum, the topics of Greatest Common Divisor (GCD) and Least Common Multiple (LCM) are consistently identified as among the most challenging for students to grasp—especially in applying these abstract concepts to real-life problem-solving contexts (Li & Tsai, 2022). Moreover, recent studies highlight that mathematics instruction in Indonesia often lacks

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contextual grounding and cultural relevance, further contributing to students' cognitive disengagement and emotional disconnection from mathematical content (Rosa & Orey, 2024). This situation is exacerbated by the continued reliance on outdated instructional models, which, according to Azmidar (Azmidar et al., 2017), leads to monotonous classroom experiences with minimal relevance to students' daily lives.

The implications of these pedagogical shortcomings are evident in national and international assessments. Research by Ni (Ni et al., 2018) underscores that poor cognitive and affective engagement in mathematics during primary school correlates with low performance at the secondary and tertiary levels. Consistently, Indonesian students' performance in international assessments such as PISA and TIMSS remains below the OECD average, reflecting systemic challenges in mathematics education (OECD, 2019; Wijaya et al., 2024). These findings call for a transformative shift in the mathematics teaching paradigm—one that aligns more closely with students' cultural realities and enhances both conceptual understanding and affective development.

In response to these challenges, ethnomathematics has emerged as a promising approach to bridge the gap between formal mathematics instruction and students' cultural contexts. Ethnomathematics is defined as the study of mathematical ideas and practices as embedded in the cultural and historical experiences of diverse communities (D'Ambrosio, 2016; Rosa & Orey, 2011; Pujiastuti et al., 2025). This approach advocates for the integration of cultural artifacts, symbols, and practices into mathematics instruction, thereby making learning more meaningful and contextually relevant (Prahmana & D'Ambrosio, 2020; Prahmana et al., 2023; Gustina et al., 2025).

Empirical studies have demonstrated that embedding local culture into mathematics education improves students' conceptual comprehension, emotional engagement, and overall learning outcomes (Larasati et al., 2025; Yanti, 2025; Prahmana et al., 2025). For instance, Abasi and Ekwueme (Abasi & Ekwueme., 2025) reported that students exposed to culturally contextualized mathematics instruction showed higher achievement in understanding mathematical concepts. Similarly, the use of traditional games, dance, and architecture as instructional contexts has been shown to enhance students' cognitive and affective domains (Hartati & Panggabean., 2023; Radiusman et al., 2021; Fauzi et al., 2022).

A recent study by Prahmana (Prahmana et al., 2025) further illustrated how embedding cultural values from the Ramayana epic within mathematics lessons not only strengthened students' emotional connection to the subject but also fostered the internalization of moral values. However, much of the current literature in ethnomathematics education tends to concentrate on geometric patterns and symmetry found in batik designs, traditional dances, or architectural structures (Prahmana & D'Ambrosio, 2020; Radiusman et al., 2021; Fauzi et al., 2022). Limited research has explored the pedagogical potential of traditional games—despite their mathematical richness and relevance for primary students.

This study aims to address that gap by investigating the educational potential of *bola bekel*, a traditional Indonesian children's game widely played in Java and Bali, as a contextual vehicle for teaching the mathematical concepts of GCD and LCM in primary schools. Traditional games such as *bola bekel* represent valuable cultural artifacts that not only promote physical dexterity but also embody mathematical structures such as repetition, sequence, pattern recognition, and numerical relationships (Zuhri et al., 2023). The rules and variations of *bola bekel*—such as the number of balls and the sequence of movements—can be modeled mathematically and used to construct problem-solving tasks related to LCM and GCD, thereby offering a culturally grounded and pedagogically sound learning experience.

Furthermore, the integration of traditional games into mathematics instruction serves dual functions: enhancing pedagogical effectiveness and contributing to cultural preservation amid the pressures of modernization. Shih (Shih., 2022) emphasized that culturally responsive education strengthens student identity and character formation by embedding social and historical values into the curriculum.

To address the identified gap, this study aims to explore and analyze the pedagogical potential of the traditional Indonesian game *bola bekel* as a culturally relevant context for teaching the mathematical concepts of LCM and GCD at the elementary school level. Anchored in the principles of

ethnomathematics, this research examines how cultural artifacts—particularly traditional games—can function as meaningful contexts that enhance students' conceptual understanding and engagement in mathematics learning. Specifically, the study seeks to investigate: (1) how the traditional game *bola bekel* can be pedagogically reconstructed to represent the mathematical concepts of LCM and GCD; (2) how the integration of bola *bekel* into mathematics instruction affects students' cognitive and affective engagement with the subject; and (3) what cultural and historical values inherent in the game contribute to character education within the elementary mathematics curriculum. Through these research inquiries, the study aspires to develop a culturally responsive instructional model that meaningfully connects mathematical content with students' sociocultural experiences, thereby contributing to the advancement of contextual and inclusive mathematics education in Indonesia.

METHODS

This study adopts an ethnographic approach within the framework of ethnomathematics to investigate the cultural practices associated with the traditional Indonesian game bola *bekel* and to examine its pedagogical potential in representing mathematical concepts, specifically LCM and GCD, in the context of elementary mathematics education. Ethnography is considered appropriate for this research design due to its strength in capturing cultural meanings from the perspective of cultural practitioners by immersing in everyday practices that reflect social, historical, and philosophical values (Hammersley & Atkinson., 2019). In this context, ethnography is employed not only as a data collection method but also as an interpretative framework to trace the connections between the structure of traditional games and the mathematical concepts that can be pedagogically reconstructed.

The ethnographic design follows Spradley's (Spradley's., 2016) model, which consists of five systematic phases: (1) identification and selection of informants, (2) conducting ethnographic interviews, (3) detailed field documentation, (4) domain and thematic analysis, and (5) formulation of cultural interpretations. The central focus of the study is to analyze *bola bekel* as a cultural artifact that embodies pedagogical potential in the teaching and learning of mathematics from an ethnomathematical perspective. The study was conducted in two primary research sites: the Museum of Education and Traditional Toys (*Museum Pendidikan dan Mainan Kolong Tangga*) in Yogyakarta, and the Indonesian Traditional Children's Games Preservation Community (Play Plus Indonesia), both of which are dedicated to the conservation and promotion of traditional games as part of Indonesia's cultural heritage.

The research participants are divided into two main groups. The first group consists of key informants—museum curators and community organizers—who were purposively selected based on their expertise and experience in the fields of cultural heritage and traditional games, particularly in relation to educational practices. The second group includes elementary school students from grades three to five who actively engage in playing bola *bekel* within their social environments. Their participation aimed to facilitate the observation of authentic gameplay practices and the identification of emerging mathematical patterns inherent in the game's structure and sequences.

Data were collected through three primary methods: semi-structured interviews, participant observation, and document analysis (Bernard, 2018). Semi-structured interviews were selected for their flexibility in eliciting in-depth responses while allowing the interviewer to adapt questions based on participants' narratives. The interview protocol was guided by ethnomathematical indicators and cultural values embedded in traditional games. Participant observations were conducted to examine students' interactions during gameplay, focusing on the emergence of mathematical phenomena and cultural expressions in natural settings. All activities were systematically documented through photographs, audio recordings, video footage, and field notes.

In addition, a literature review was undertaken to analyze relevant scholarly articles, books, and supporting documents that provide theoretical and philosophical insights into the traditional game and its mathematical representations. This secondary data served to reinforce and contextualize the field findings. To ensure data credibility and validity, triangulation was applied by comparing data across different sources (interviews, observations, and literature) and through methodological triangulation. Validation of interpretations was further enhanced by involving key

analysis employed Spradley's (Spradley's., 2016) domain and thematic analysis techniques, involving the identification of cultural meaning units, construction of domains, and the mapping of empirical findings to the mathematical representations of LCM and GCD embedded within the gameplay structure of bola *bekel*. This analysis also considered the philosophical meanings embedded in the game that contribute to the cultivation of student character within a culturally embedded educational framework.

Ultimately, this methodological approach is intended to contribute to the development of a culturally responsive and contextually meaningful instructional model for teaching mathematics, rooted in local cultural traditions. Moreover, the study's findings are expected to support the preservation of Indonesia's traditional games by integrating them meaningfully into elementary mathematics curricula.

FINDINGS

The findings of this study reveal that the traditional game of *bekel* ball is not merely a form of cultural heritage but also contains mathematical structures that can be utilized for teaching the concepts of LCM and GCD in elementary schools. The analysis indicates that the game possesses both educational and philosophical values that enrich the learning context of mathematics. This section presents the findings beginning from the historical and cultural significance of *bekel* ball, followed by the analysis of its mathematical elements and pedagogical implications.

Traditional game of *Bekel*: Historical and cultural context

Historically, *bekel* ball is rooted in a broader tradition known internationally as knucklebones—a game that originally employed small animal bones (typically from goats or sheep) as its primary playing tools. These bones were not only used for gameplay but also functioned as counting devices, akin to the role of dice in modern games (Dasen & Vespa., 2021). In Europe, particularly in the Netherlands, the game is known as bikkelen, meaning "to slam bones." During the colonial era, the game was introduced to Indonesia and subsequently adapted to local contexts. The bones were replaced with metal (e.g., brass or tin), and later plastic, to accommodate mass production and local usage. A rubber ball was incorporated into the game as the central tool for bouncing and timing actions.

Beyond entertainment, the *bekel* ball game embodies values of education and character development. Interviews conducted with curators of the Kolong Tangga Educational and Toy Museum and the Play Plus Indonesia community reveal that the game fosters honesty, agility, concentration, patience, self-regulation, and strategic thinking. These values align closely with the character education goals embedded in the Indonesian National Curriculum. As a representation of local wisdom derived from students' everyday lives in the past, the game constitutes a form of intangible cultural heritage that warrants preservation (Dasen & Vespa, 2021).

Mathematical concepts of LCM and GCD in the traditional game of *Bekel*

In addition to its cultural and character-building components, *bekel* ball integrates inherent mathematical structures relevant for instruction—specifically in understanding multiples and factors, including LCM and GCD. The gameplay involves sequential steps, repetition, and systematic distribution of objects, which correspond closely to fundamental concepts in mathematics. The researchers identified multiple opportunities within the game to explore and internalize the notions of multiples and common factors through authentic, hands-on experiences.

Figure 1 illustrates the traditional Indonesian children's game called *bekel*, focusing on the process of picking up the *bekel* pieces (typically small metal or plastic objects) one by one while a ball is bounced. The key mathematical concept embedded in this activity lies in sequential thinking, counting, and hand-eye coordination, which are fundamental cognitive skills in early mathematics learning.

During the game, players are required to bounce the ball and, within the time the ball is in the air, pick up a specific number of *bekel* pieces (starting from one and increasing sequentially), and catch the ball again before it touches the ground. This process implicitly develops students' understanding of one-to-one correspondence, subitizing (recognizing small quantities without

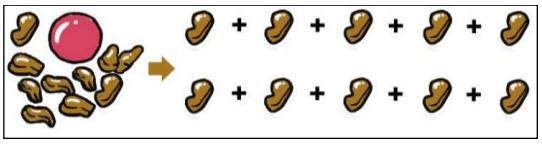

Figure 1. The mathematical concept of *bekel* illustrated through the process of picking up *bekel* pieces sequentially during gameplay

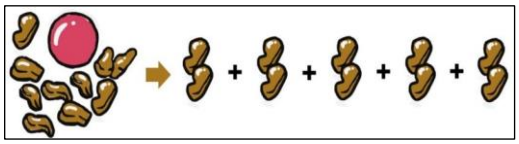

Figure 2. Picking up 2 *bekel* pieces representing the concept of the multiple of 2

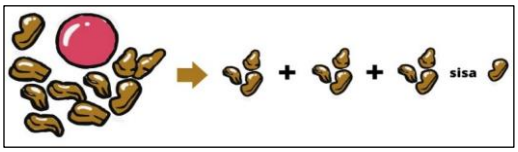

Figure 3. Picking up 3 *bekel* pieces as a representation of the concept of multiples of 3

counting), and ordinal numbers. Moreover, the activity requires strategic planning and timing, introducing elements of problem-solving and logical sequencing.

For example, the concept of multiples is observable in the sequence of picking up *bekel* pieces, where each round increases the quantity picked per bounce, following a numerical pattern akin to repeated addition or multiplication. If ten *bekel* pieces are used, a player starts by picking up one piece at a time, then progresses to picking up two at a time, three, and so on. The number of repetitions required in each stage reflects whether the total (e.g., 10) is a multiple of the number picked. Finally, an elaboration of how specific multiples are embedded within the structure of the game presents as follows.

Multiple of 2

Figure 2 demonstrates the application of the concept of multiples of 2 through the traditional *bekel* game, specifically in the stage where players are required to pick up two *bekel* pieces in a single bounce of the ball. This stage encourages students to conceptualize the number 2 not as an isolated digit, but as a unit of grouping that recurs in a consistent, structured pattern.

The visual and kinesthetic experience of picking up *bekel* pieces in pairs reinforces the mathematical notion of even numbers and multiples of 2, such as 2, 4, 6, 8, and so on. This repetitive action can be mathematically interpreted as repeated addition: $2 + 2 + 2 + \ldots$ or as multiplication: $1 \times 2 = 2$, $2 \times 2 = 4$, $3 \times 2 = 6$, etc.

Through this cultural context, learners not only practice recognizing numerical patterns but also develop an intuitive understanding of multiplication as repeated grouping. Additionally, the game integrates motor coordination and spatial awareness, which enhances cognitive engagement and supports multisensory learning of mathematical concepts.

Multiple of 3

In more advanced stages, players are challenged to pick up three *bekel* pieces per turn. This requires an understanding of multiples of 3 (3, 6, 9, 12, …), as players must time their actions and estimate step combinations precisely.

Figure 3 illustrates the action of picking up three *bekel* pieces in a single turn, which concretely represents the concept of multiples of 3. This activity demonstrates repeated addition $3 + 3 + 3 + \ldots$ or multiplication of 3 by natural numbers in sequence, such as $1 \times 3 = 3$, $2 \times 3 = 6$, $3 \times 3 = 9$, and so forth. Through the movement patterns and rhythm of the game, students can strengthen their understanding of multiples of 3 while also developing their counting skills and motor coordination.

Multiple of 4

When players strategize to pick up four *bekel* pieces simultaneously, they engage with multiples of 4 (4, 8, 12, …). This task often involves spatial arrangement of the pieces to be grabbed together, thus integrating visual-spatial reasoning with numerical understanding. Such activity exemplifies how multiples of 4 can be learned not only abstractly but also through strategic planning and spatial awareness, promoting deeper cognitive links between number concepts and physical actions.

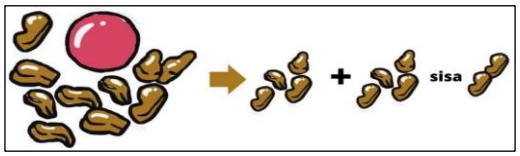

Figure 4. Picking up 4 *bekel* pieces as a representation of the concept of multiples of 4

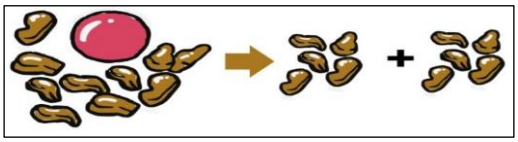

Figure 5. Picking up 5 *bekel* pieces as a representation of the concept of multiples of 5

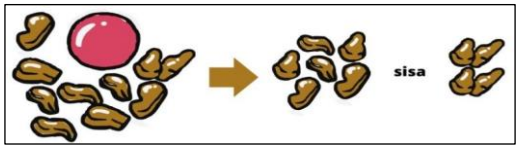

Figure 6. Picking up 6 *bekel* pieces as a representation of the concept of multiples of 6

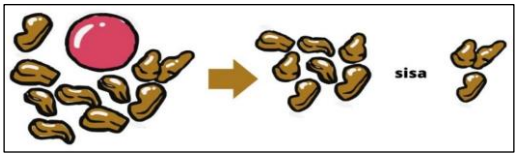

Figure 7. Picking up 7 *bekel* pieces as a representation of the concept of multiples of 7

Figure 4 illustrates the action of picking up four *bekel* pieces in one turn, representing the concept of multiples of 4 (4, 8, 12, 16, …). This activity shows repeated addition 4 + 4 + 4 + … or multiplication of 4 by natural numbers sequentially such as 1×4=4, 2×4=8, 3×4=12, and so forth. Through this pattern of picking up, students can concretely understand multiples of 4 while also developing strategy and movement coordination.

Multiple of 5

The game frequently cycles through stages involving picking 1 to 5 pieces in sequence, reinforcing multiples of 5 (5, 10, 15, …). This cyclical pattern mirrors everyday numerical groupings, such as counting by fives in time, money, or measurement contexts. Recognizing these cycles in gameplay helps students internalize the concept of multiples of 5 as foundational in practical, real-world applications.

Figure 5 illustrates the action of picking up five *bekel* pieces in one turn, representing the concept of multiples of 5 (5, 10, 15, and so on). In the *bekel* game, the cycle of picking pieces is often divided into levels that repeat in multiples of 5. For example, after a sequence of taking 1, 2, 3, 4, and 5 pieces, the game cycle returns to the beginning. This pattern helps students understand the concept of multiples of 5 through repetitive and continuous activity. Multiples of 5 are obtained by repeated addition of 5 + 5 + 5 + … or by multiplying the number 5 by natural numbers in order, such as 1×5=5, 2×5=10, 3×5=15, and so forth.

Multiple of 6

Figure 6 illustrates the process of picking up six *bekel* pieces in a single turn, symbolizing the concept of multiples of 6 (6, 12, 18, and so on). When students reach this level, they demonstrate an understanding and internalization of grouping in multiples of 6. This reflects a combination of mathematical skills and cognitive abilities such as concentration, long-term memory, and time management. Engaging in this activity also sharpens their comprehension of composite numbers. Multiples of 6 are obtained through repeated addition, such as 6 + 6 + 6 + …, or by multiplying the number 6 by natural numbers in sequence, for example, 1×6=6, 2×6=12, 3×6=18, 4×6=24, and so forth.

Multiple of 7

Although multiples of 7 (7, 14, 21, …) are less commonly taught concretely, the *bekel* game provides a rare kinesthetic opportunity to experience these groupings. Picking up seven pieces requires precise timing and technique, fostering logical mathematical thinking and reinforcing less intuitive numerical patterns.

Figure 7 illustrates the action of picking up seven *bekel* pieces in one turn, representing the concept of multiples of 7 (7, 14, 21, 28, etc.). Multiples of 7 are obtained through repeated addition, such as 7 + 7 + 7 + …, or by multiplying the number 7 by natural numbers in sequence, for example, 1×7=7, 2×7=14, 3×7=21, 4×7=28, and so on.

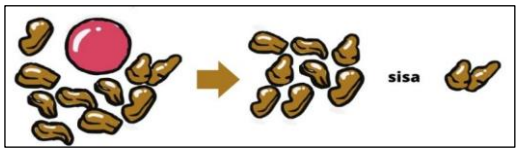

Figure 8. Picking up 8 *bekel* pieces as a representation of the concept of multiples of 8

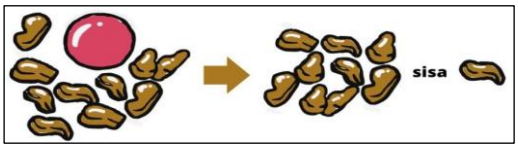

Figure 9. Picking up 9 *bekel* pieces as a representation of the concept of multiples of 9

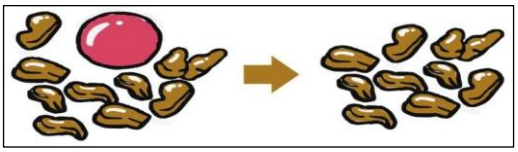

Figure 10. Picking up 10 *bekel* pieces as a representation of the concept of multiples of 10

Multiple of 8

At this advanced level, players must recognize and execute patterns involving eight pieces, thus working with multiples of 8 (8, 16, 24, …). This stage encourages procedural discipline and an understanding of repetitive numerical patterns, as the fixed sequence of moves must be followed accurately for successful gameplay.

Figure 8 illustrates the process of picking up eight *bekel* pieces at once, symbolizing the concept of multiples of 8 (8, 16, 24, 32, etc.). Multiples of 8 are formed by repeated addition such as 8 + 8 + 8 + …, or by multiplying the number 8 by natural numbers sequentially, for example, 1×8=8, 2×8=16, 3×8=24, 4×8=32, and so forth.

Multiple of 9

The challenge of taking nine *bekel* pieces at once exercises students' memory and positional awareness. Multiples of 9 (9, 18, 27, …) serve to develop mental structuring skills and reinforce mathematical orderliness. This stage highlights how numerical logic and kinesthetic activities can converge to deepen numerical cognition.

Figure 9 demonstrates the activity of picking up nine *bekel* pieces in a single turn, representing the concept of multiples of 9 (9, 18, 27, 36, etc.). Multiples of 9 are obtained through repeated addition such as 9 + 9 + 9 + …, or by multiplying the number 9 by natural numbers sequentially, for instance, 1×9=9, 2×9=18, 3×9=27, 4×9=36, and so on.

Multiple of 10

The peak level often involves picking up ten pieces, representing multiples of 10 (10, 20, 30, …). This is significant because 10 is the base of the decimal system and fundamental to primary arithmetic learning. Mastery at this stage symbolizes both technical skill and conceptual understanding of our number system's structure.

Figure 10 illustrates the activity of picking up ten *bekel* pieces in one turn as a representation of the concept of multiples of 10 (10, 20, 30, 40, etc.). Multiples of 10 are obtained through repeated addition such as 10 + 10 + 10 + …, or by multiplying the number 10 by natural numbers sequentially, for example, 1×10=10, 2×10=20, 3×10=30, 4×10=40, and so on.

Understanding the concept of factors through the *Bekel* Game

In the traditional *bekel* game, the concept of factors can be intuitively introduced through the process of grouping and retrieving the *bekel* seeds without remainder. For instance, if there are 4 *bekel* pieces, a player may take them one by one (1 piece), in pairs (2 pieces), or all at once (4 pieces). These grouping strategies illustrate that 1, 2, and 4 are factors of 4, as each can divide the total number of pieces evenly. In contrast, attempting to take 3 pieces at once leaves one piece remaining, indicating that 3 is not a factor of 4. This concrete representation enables students to internalize the mathematical concept of factors in an engaging and meaningful manner.

Introduction to the LCM through *Bekel* game contexts

Although the concept of LCM does not explicitly appear during *bekel* gameplay, the structure of the game lends itself well to modeling real-life applications of multiples and common multiples. For example, consider a situation in which two groups of students take turns throwing the ball: one group throws every 4 seconds, and the other every 6 seconds. To determine when both groups will

throw the ball simultaneously, students must identify the LCM of 4 and 6, such as multiples of 4: 4, 8, 12, 16, 20, 24, … and multiples of 6: 6, 12, 18, 24, 30, …

The numbers 12 and 24 appear in both sequences, with 12 being the smallest common multiple. Therefore, the LCM of 4 and 6 is 12. This contextualized scenario helps students comprehend the LCM concept in a meaningful, applied setting—such as scheduling turn-taking intervals to avoid conflicts—thereby enhancing their mathematical reasoning and relevance to daily life.

Application of the GCD through fair grouping

The concept of the Greatest Common Divisor (GCD) can be effectively introduced using the factorization strategies explored in the *bekel* game. For example, suppose there are 24 and 36 *bekel* seeds available. To divide them into equal groups without leftovers, students must determine the largest number that divides both quantities evenly. For example: Factors of 24: 1, 2, 3, 4, 6, 8, 12, 24; Factors of 36: 1, 2, 3, 4, 6, 9, 12, 18, 36; and Common factors: 1, 2, 3, 4, 6, 12.

The largest common factor is 12, making it the GCD of 24 and 36. This scenario allows students to visualize and apply the GCD concept through a culturally meaningful activity involving fair distribution, reinforcing their understanding of number relationships in a tangible and equitable context.

Philosophical interpretation and pedagogical relevance

Traditional games such as *bekel* serve not only as cultural heritage but also as pedagogical tools that embody philosophical and character-building values. Every movement in the game requires perseverance, focus, and self-discipline. These values align closely with the character education principles emphasized in 21st-century learning, particularly the development of students' social and emotional competencies. Mistakes at any stage of the game can disrupt progress, teaching students patience, reflection, and appreciation for gradual learning processes. Additionally, the game promotes sportsmanship and diligence, as each level must be completed meticulously without cheating.

The integration of cultural values and mathematical structures within the *bekel* game makes it an ideal medium for implementing an ethnomathematics-based learning approach. By leveraging familiar cultural contexts, teachers can design more contextual, engaging, and meaningful mathematics lessons. This approach not only enhances student motivation but also deepens their conceptual understanding of abstract mathematical topics such as factors, multiples, LCM, and GCD.

DISCUSSION

The findings of this study highlight the pedagogical potential of traditional games—specifically the *bekel* game—not merely as recreational tools but as culturally grounded learning media that support the development of mathematical understanding. Far from being limited to motor or social skill development, the *bekel* game demonstrates an underlying mathematical structure that can be leveraged to contextualize fundamental concepts such as factors, multiples, LCM, and GCD.

This research aligns with the ethnomathematical framework proposed by Rosa and Orey (Rosa & Orey., 2024), who argue that mathematics is not a culturally neutral or isolated discipline but rather one that emerges from real-world practices shaped by cultural contexts. Within this perspective, mathematical concepts should be explored not only through abstract formalism but also through meaningful connections with students' cultural backgrounds. The *bekel* game, as a form of cultural artifact, thus becomes a valuable didactical tool that fosters the integration of students' lived experiences with formal mathematical reasoning.

Through engaging in the *bekel* game, students naturally encounter mathematical situations that require them to recognize numerical patterns, categorize quantities, and analyze divisibility. For instance, the ability to group or divide *bekel* seeds without remainder provides a tangible and enjoyable means for students to develop a conceptual understanding of factors. Similarly, temporal coordination in multi-group gameplay (e.g., players taking turns every few seconds) presents opportunities for introducing LCM and GCD in a contextually relevant and cognitively accessible manner.

These findings are supported by Andersson (Andersson et al., 2015), who found that mathematics instruction that incorporates students' cultural contexts enhances both cognitive engagement and conceptual understanding. The use of culturally responsive pedagogy, especially when embedded in traditional games, not only sustains student interest but also reinforces the relevance of mathematics in their everyday lives (Risdiyanti et al., 2019). Such integration can help to bridge the disconnect that students often experience between abstract mathematical instruction and their informal knowledge systems (Prahmana et al., 2025). Moreover, the pedagogical significance of the *bekel* game extends beyond cognitive outcomes to include character education. Participation in the game requires self-discipline, precision, perseverance, and fairness—values that align with the broader goals of 21st-century education. The structured nature of the game, combined with its competitive and collaborative elements, provides a fertile ground for cultivating both academic and socio-emotional competencies.

This study also supports the "funds of knowledge" concept introduced by Moll (Moll et al., 2006), which emphasizes the importance of recognizing and utilizing the cultural resources that students bring to the classroom. In this case, familiarity with the rules, structure, and rhythm of the *bekel* game becomes a form of culturally embedded knowledge that can be mobilized to facilitate the transition from informal to formal mathematical concepts. Teachers act as mediators who connect students' experiential knowledge with curriculum-based abstractions (Cheung et al., 2022).

The effective use of traditional games such as *bekel* also highlights the importance of culturally sustaining pedagogy in mathematics education. By embedding local cultural practices into classroom instruction, educators not only validate students' cultural identities but also diversify pedagogical strategies to accommodate varied learning styles (Markey et al., 2021). This is particularly relevant in multilingual and multicultural societies where mainstream curricula often fail to reflect students' sociocultural realities (Veliz & Chen, 2024).

Furthermore, integrating the *bekel* game into mathematics instruction supports constructivist approaches to learning, whereby students actively construct meaning from hands-on activities and real-life scenarios. Instead of passively receiving knowledge, students engage in exploratory learning experiences that enhance their problem-solving skills and promote a deeper understanding of number theory through pattern recognition and logical reasoning. The adaptability of this approach also makes it relevant beyond the Indonesian context. Many countries possess rich traditions of local games that remain untapped as educational resources (Qirom & Juandi, 2023). By adopting a culturally grounded framework such as ethnomathematics, educators worldwide can uncover and integrate indigenous knowledge systems into formal learning environments, thereby enriching mathematics education through locally meaningful practices (Zuhri et al., 2023).

Finally, the present study underscores the value of utilizing traditional cultural games as pedagogical tools to promote mathematical understanding. It also contributes significantly to the growing body of literature in culturally responsive mathematics education by empirically demonstrating how traditional games, such as *bekel*, can serve as meaningful pedagogical tools that bridge informal cultural practices and formal mathematical concepts. The study not only validates the ethnomathematical framework as an effective approach to contextualize mathematical learning but also opens new avenues for researchers to explore indigenous and localized knowledge systems as rich sources of mathematical thinking.

CONCLUSIONS

This study has demonstrated that the traditional game of bola *bekel* can be effectively utilized as a culturally embedded instructional medium for teaching foundational mathematical concepts, including factors, multiples, LCM, and GCD. By employing an ethnographic approach grounded in ethnomathematics, this research provides empirical evidence that the integration of cultural practices into mathematics education not only enhances conceptual understanding but also enriches students' learning experiences by connecting abstract content with familiar, real-world contexts. The incorporation of bola *bekel* into classroom activities promotes contextualized learning, supports students' identity formation, and cultivates core values such as perseverance, fairness, and critical thinking—aligning well with the broader objectives of character education in the 21st century.

Despite its contributions, this study is not without limitations. The scope of the research was confined to a specific cultural context and a limited number of mathematical topics, potentially

restricting the generalizability of its findings. Moreover, the implementation was primarily observational, lacking longitudinal data to assess long-term impacts on mathematical achievement. Therefore, for future mathematics education researchers, this work provides a methodological and theoretical foundation for designing instructional interventions that leverage students' cultural backgrounds to improve engagement, conceptual understanding, and academic equity. Furthermore, the integration of cultural artifacts like traditional games offers a replicable model for curriculum innovation in multicultural and multilingual contexts, emphasizing the importance of inclusive pedagogy. This study also invites further interdisciplinary research collaborations among educators, anthropologists, and curriculum designers to document, analyze, and integrate diverse cultural practices into mathematics education. By situating mathematical learning within students' sociocultural realities, future research can continue to challenge dominant paradigms of mathematics instruction and contribute to the development of more equitable and culturally sustaining education systems globally.

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