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ETHNOMATHEMATICS OF THE CONGKLAK GAME: A SYSTEMATIC REVIEW OF MATHEMATICAL CONCEPTS AND THEIR IMPLEMENTATION IN LEARNING

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ABSTRACT

Ethnomathematics in mathematics education seeks to bridge abstract mathematical concepts with students' cultural experiences, thereby enhancing the relevance and meaningfulness of learning. Traditional games represent a valuable cultural resource for contextualizing mathematics, and the Indonesian game *congklak* is widely recognized for embedding rich mathematical ideas within its structure and gameplay. This study aims to systematically review the mathematical concepts present in the *congklak* game and examine their implementation in mathematics education. A qualitative systematic literature review was conducted using articles retrieved from the Google Scholar database. The search applied specific keywords related to ethnomathematics, *congklak*, and mathematics education, with clearly defined inclusion and exclusion criteria. Ten peer-reviewed articles published between 2019 and 2024 were selected and analyzed through data reduction, organization, and synthesis. The findings show that *congklak* incorporates multiple mathematical concepts, including counting and number sequencing, arithmetic operations (addition, subtraction, multiplication, and division), geometry (plane figures, solid figures, and reflection), linear equations in one variable, and basic profit-and-loss concepts. The reviewed studies also report positive effects on students' conceptual understanding, learning motivation, engagement, and critical thinking skills. In conclusion, congklak serves as an effective ethnomathematical learning medium that supports meaningful and contextual mathematics instruction while also contributing to cultural preservation and strengthening students' awareness of mathematics in everyday life.

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INTRODUCTION

Mathematics education holds a strategic role in developing students' logical, analytical, and creative thinking skills. These competencies constitute an essential foundation for addressing the challenges of the 21st century, which demand individuals to think critically, make decisions, and solve problems effectively (Anderson, 2010). However, mathematics learning is often perceived as abstract and irrelevant to daily life, resulting in low student motivation. To address

this challenge, the ethnomathematics approach offers a promising alternative. By integrating elements of local culture into instruction, ethnomathematics can connect mathematical concepts with students' real-life experiences, making learning more meaningful (D'Ambrosio, 2016).

One form of integrating local culture into ethnomathematics is through traditional games. Essentially, traditional games do not have rigid rules; instead, they depend on local customs and agreements among players (Febrina et al., 2023). One such traditional game found in Indonesia is congklak.

Figure 1. Congklak Game (TGR Campaign Documentation)

Congklak, as part of Indonesia's cultural heritage, serves as a concrete example of a cultural practice that contains mathematical concepts. It involves arithmetic operations, patterns, and combinatorics, while also encouraging strategic decision-making (Fitriani et al., 2020). More than just a game, congklak offers opportunities to introduce mathematical concepts in a fun and contextual manner. Previous studies have shown that traditional games can enhance student engagement, build cultural connections, and strengthen the understanding of mathematical concepts (Fitrianawati et al., 2020). This aligns with the Merdeka Belajar Curriculum, which emphasizes the importance of culture-based education for fostering national character (Kemendikbud, 2021).

Despite the significant potential of congklak in mathematics instruction, in-depth studies systematically linking cultural aspects with mathematical concepts remain limited. Most existing research is exploratory or descriptive and does not provide clear guidance for implementation in formal learning settings (Rosa & Orey, 2017). This gap highlights the need for a more structured investigation to explore the mathematical concepts embedded in congklak and how these concepts can be effectively implemented in teaching.

This study aims to fill this gap by conducting a systematic review of congklak as a culturally based mathematics learning medium. The novelty of this research lies in its integrative approach, connecting ethnomathematics theory with practical applications in the classroom. By analyzing relevant studies, this research is expected to produce a comprehensive guideline for educators and researchers to develop creative, relevant, and culturally grounded instructional methods (Gay, 2018). The study also highlights how congklak can be used to strengthen students' critical thinking and problem-solving skills, thereby contributing not only to academic development but also to character formation.

The main output of this systematic review is a comprehensive synthesis of mathematical concepts embedded in the traditional *congklak* game and their documented implementation in mathematics learning. This synthesis provides a structured reference for integrating ethnomathematical approaches into classroom instruction, particularly to support more engaging and meaningful mathematics learning (Johnson & Johnson, 2014). The findings of this study offer benefits to various stakeholders, including mathematics teachers, curriculum developers, and researchers. Educators may use the results as guidance for designing culturally

responsive instructional strategies, while researchers can utilize the synthesized evidence as a basis for further empirical studies in ethnomathematics. From a cultural perspective, this study supports the preservation of *congklak* as part of Indonesia's cultural heritage by promoting its use in formal education (Haryanto, 2019). In the context of Indonesian education, this research is highly relevant as it aligns with the national vision of culture-based education and the Merdeka Belajar curriculum, which emphasizes contextual learning, student engagement, and character development (Kemendikbud, 2021). By integrating local culture into mathematics instruction, this study contributes to making mathematics learning more connected to students' everyday lives while reinforcing cultural identity.

METHOD

This study employs an exploratory qualitative approach using a systematic review method to examine the ethnomathematical concepts embedded in the congklak game and their implementation in mathematics learning. The research design applied is a literature study aimed at collecting, analyzing, and synthesizing relevant findings from existing literature. Data collection was conducted through a systematic search of the literature. The source of data consisted of secondary data in the form of published research articles. The literature search was carried out using the Google Scholar database. The search and selection process involved identifying key terms such as "ethnomathematics," "congklak game," "mathematics learning," and "cultural approaches in mathematics education." Articles obtained from the search were then screened based on the following inclusion and exclusion criteria:

Inclusion Criteria

1. Articles published within the last six years (2019–2024).
2. Studies focusing on ethnomathematics of the congklak game in mathematics learning.
3. Articles available in Indonesian to ensure accurate comprehension.

Exclusion Criteria

1. Articles without full access (abstract-only or not fully available).
2. Articles irrelevant to mathematics education or not involving traditional games such as congklak.
3. Articles that address congklak solely as a traditional game without linking it to mathematical concepts.
4. Publications that are general reviews lacking a clear research methodology.

The systematic review in this study focuses on identifying mathematical concepts within the congklak game and their implementation in classroom mathematics instruction. The data analysis technique was carried out in three stages: data reduction, data presentation, and drawing conclusions or data verification.

RESULTS AND DISCUSSION

Results

This systematic review aims to identify the mathematical concepts embedded in the traditional congklak game and examine how these concepts are implemented in mathematics learning. Based on the inclusion and exclusion criteria established in this study, 10 relevant articles published between 2019 and 2024 were selected for further analysis.

Table 1. Summary of the Ten Selected Studies

No	Authors & Year	Mathematical Concepts	Implementation in Instruction
1.	Febriyanti et al. (2019)	1. Counting and Number Sequencing	1. Contextual Learning 2. Enhancing Student Interest and Understanding 3. Developing Cognitive, Social, Emotional, and Critical Thinking Skills 4. Cultural Preservation 5. Curriculum Integration
2.	Rohmatin (2020)	1. Counting and Number Sequencing 2. Arithmetic Operations (Addition and Subtraction) 3. Geometry (Plane Geometry, Solid Geometry)	1. Developing Cognitive, Social, Emotional, and Critical Thinking Skills 2. Curriculum Integration
3.	Karina et al. (2021)	1. Counting and Number Sequencing; 2. Arithmetic Operations (Addition and Subtraction);	1. Use of Media and Development of Learning Materials 2. Developing Cognitive, Social, Emotional, and Critical Thinking Skills 3. Curriculum Integration
4.	Febrina et al. (2022)	1. Counting and Number Sequencing 2. Arithmetic Operations (Addition and Subtraction)	1. Use of Media and Development of Learning Materials
5.	Fajriyah & Maharbid (2023)	1. Counting and Number Sequencing 2. Arithmetic Operations (Division)	1. Contextual Learning 2. Use of Media and Development of Learning Materials 3. Enhancing Student Interest and Understanding 4. Curriculum Integration
6.	Jannah et al. (2023)	1. Geometry (Plane Geometry, Solid Geometry)	1. Use of Media and Development of Learning Materials
7.	Nurazizah (2023)	1. Arithmetic Operations (Addition and Subtraction, Multiplication) 2. Geometry (Solid Geometry)	1. Enhancing Student Interest and Understanding 2. Developing Cognitive, Social, Emotional, and Critical Thinking Skills 3. Cultural Preservation
8.	Asmaarobiyah & Arisetyawan (2024)	1. Arithmetic Operations (Addition and Subtraction)	1. Developing Cognitive, Social, Emotional, and Critical Thinking Skills 2. Curriculum Integration
9.	Reza et al. (2024)	1. Arithmetic Operations (Addition and Subtraction, Division, Multiplication)	1. Curriculum Integration

		2. Geometric Transformations: Reflection 3. Linear Equations in One Variable 4. Profit and Loss	
10.	Sili & Towe (2024)	1. Arithmetic Operations (Addition and Subtraction, Multiplication) 2. Geometry (Plane Geometry, Solid Geometry, Geometric Transformations: Reflection)	1. Curriculum Integration

The selected studies reveal that the congklak game contains various mathematical concepts that can be integrated into mathematics instruction. These concepts include counting and number sequencing, arithmetic operations (addition, subtraction, multiplication, and division), geometry (plane figures, solid figures, and reflection), linear equations in one variable, and basic economic concepts such as profit and loss.

Table 1 summarizes the key findings from the selected studies, including the mathematical concepts identified in the congklak game and their implementation in mathematics learning. The analysis indicates that arithmetic operations and counting skills are the most frequently identified mathematical concepts in the congklak game, as they are directly related to the process of distributing and collecting seeds during gameplay.

In addition, several studies highlight the potential of the congklak board to illustrate geometric concepts, such as shapes, symmetry, and spatial relationships, which can support students' understanding of geometry in a concrete and contextual manner.

Furthermore, the reviewed literature indicates that the congklak game has been implemented in mathematics learning through several instructional approaches, including contextual learning, the use of learning media, the development of teaching materials, and integration into the mathematics curriculum. These implementations contribute to improving students' conceptual understanding, learning motivation, engagement, and critical thinking skills.

Overall, the results of this review demonstrate that the congklak game has significant potential as an ethnomathematics-based learning medium that connects mathematical concepts with students' cultural experiences, thereby making mathematics learning more meaningful and engaging.

Discussions

The congklak game is a traditional game that naturally contains mathematical elements. These concepts can be incorporated into mathematics instruction to enhance students' understanding through a culturally grounded or ethnomathematical approach (D'Ambrosio, 2016; Rosa & Orey, 2017). The systematic review of the ten selected articles revealed several mathematical concepts present in the game, including counting and number sequencing; arithmetic operations; geometry; linear equations in one variable; and profit and loss.

Students learn to count in an enjoyable way. They must count the number of seeds in each hole and ensure that each seed is counted once, thereby improving their counting skills (Karina et al., 2021; Fajriyah & Maharbid, 2023; Rohmatin, 2020). Students count the number of large holes, small holes, and seeds they possess to determine the winner based on the total number of collected seeds (Febriyanti et al., 2019; Febrina et al., 2023). Players also follow a specific order when taking seeds from the holes, which helps students recognize natural numbers and reinforces counting skills when verifying the number of seeds in each hole on the congklak board (Karina et al., 2021).

The congklak game involves basic arithmetic operations such as addition, subtraction, multiplication, and division. Players must count the number of seeds in each hole and subtract seeds as they are removed (Karina et al., 2021; Febrina et al., 2023; Nurazizah, 2023; Reza et al., 2024; Rohmatin, 2020; Sili & Towe, 2024). Integrating the congklak game into mathematics instruction has been shown to be moderately effective in significantly improving students' critical thinking skills in arithmetic operations (Asmaarobiyah & Arisetyawan, 2024).

Players must distribute seeds evenly across the holes, directly relating to the mathematical concept of division (Fajriyah & Maharbid, 2023; Sili & Towe, 2024; Reza et al., 2024). Fajriyah & Maharbid (2023) concluded that the ethnomathematics of the congklak game positively influences students' conceptual understanding of division. The game can also be used to teach comparison concepts, such as comparing the number of seeds in the main hole to determine the winner (Reza et al., 2024). When each hole is filled with a specific number of seeds, students can determine the total number of seeds by multiplying the number of holes by the number of seeds per hole (Nurazizah, 2023; Sili & Towe, 2024). For instance, each player fills seven holes with seven seeds each, resulting in a total of 49 seeds (Reza et al., 2024).

The congklak game can be integrated with geometric concepts, particularly plane and solid shapes. The congklak board has rectangular and square shapes, which help teach the properties of two-dimensional figures (Jannah et al., 2023; Rohmatin, 2020; Sili & Towe, 2024). The overall design of the board introduces geometric shapes such as circles, squares, and rectangles. The seed containers on the board are shaped like hemispheres, which can be used to explain three-dimensional shapes (Jannah et al., 2023; Rohmatin, 2020; Sili & Towe, 2024; Nurazizah, 2023). Using the congklak board, teachers can illustrate these shapes within the context of the game (Nurazizah, 2023). The holes on the board are arranged symmetrically, allowing teachers to introduce the concept of reflection (Reza et al., 2024; Sili & Towe, 2024).

Students can learn about linear equations through the game (Reza et al., 2024). For example, if the seventh hole contains only five seeds, students can be asked how many seeds are needed to reach the main hole, which can be expressed as a linear equation. Also this game incorporates basic economic concepts such as gain and loss. The player who collects more seeds gains an advantage, which can be analyzed mathematically (Reza et al., 2024).

The congklak game has been integrated into mathematics instruction through various approaches. Key implementations found in the literature include contextual learning; use of media and development of learning materials; enhanching students' interest and understanding; developing cognitive, social, emotional and critical thinking skills; cultural preservation; and curriculum integration.

Congklak serves as a tool for teaching mathematical concepts within a broader context. By linking mathematics with traditional games, students can see its relevance to everyday life (Fajriyah & Maharbid, 2023; Febriyanti et al., 2019). Fajriyah & Maharbid (2023) found that the ethnomathematical approach significantly improved students' conceptual understanding of division, with experimental groups outperforming control groups. This approach aligns with contextual learning theory (Johnson & Johnson, 2014), which emphasizes connecting academic concepts to real-life experiences.

Teachers can use congklak as an interactive learning medium, making mathematical concepts more concrete and enjoyable (Karina et al., 2021). Fajriyah & Maharbid (2023) found that students taught with congklak demonstrated significantly better understanding compared to traditional methods. Jannah et al. (2023) showed that the congklak game effectively supports learning plane and solid geometry. Febrina et al. (2022) developed valid, practical, and effective lesson plans (RPP) and student worksheets (LKPD) integrating ethnomathematics, contributing to improved mathematical skills.

Nurazizah (2023) reported that ethnomathematics-based congklak learning increases student interest and comprehension. The game makes mathematics enjoyable rather than intimidating. Similarly, Fajriyah & Maharbid (2023) and Febriyanti et al. (2019) found that congklak motivates students and fosters enthusiasm in learning.

The congklak game enhances analytical and strategic thinking, fine motor skills, patience, precision, independence, honesty, sportsmanship, perseverance, optimism, and attention to detail (Febriyanti et al., 2019; Karina et al., 2021; Rohmatin, 2020; Nurazizah, 2023). It also fosters social skills such as cooperation and emotional regulation (Rohmatin, 2020). Asmaarobiyah & Arisetyawan (2024) concluded that congklak-based ethnomathematical learning is moderately effective in improving students' mathematical critical thinking skills.

The congklak game also serves as a means of preserving Indonesian culture (Nurazizah, 2023; Febriyanti et al., 2019). Teaching it in schools helps students appreciate their cultural heritage. The congklak game can be integrated into the mathematics curriculum, especially for teaching number operations and geometry (Karina et al., 2021; Fajriyah & Maharbid, 2023; Febriyanti et al., 2019; Asmaarobiyah & Arisetyawan, 2024; Reza et al., 2024; Rohmatin, 2020; Sili & Towe, 2024).

CONCLUSION

This study confirms that the congklak game is an effective instructional medium for integrating ethnomathematical concepts into mathematics education. The systematic review findings reveal that congklak encompasses various mathematical concepts, counting and number sequencing, arithmetic operations (addition, subtraction, multiplication, and division), geometry (plane figures, solid figures, and transformational geometry: reflection), linear equations in one variable, as well as concepts of profit and loss, which can be effectively integrated into mathematics learning.

Through a contextual approach, the game not only enhances students' understanding of mathematical concepts but also increases their engagement, motivation, and analytical and strategic thinking skills. Teachers can utilize congklak as an interactive learning medium, as a basis for developing instructional materials, and as a means to improve students' interest, comprehension, and cognitive, social, emotional, and critical thinking abilities. Beyond its academic benefits, the implementation of the congklak game in mathematics instruction also carries significant cultural value. Its use helps preserve local cultural heritage while enriching culturally based pedagogical practices that are more meaningful and engaging for students. The findings further indicate that integrating congklak into the mathematics curriculum helps students recognize that mathematics is not merely an abstract discipline, but also an inherent part of everyday life.

Future studies are recommended to investigate the effectiveness of congklak-based learning across different educational levels and mathematical topics through empirical research designs. In addition, further research may explore the integration of other traditional games into mathematics education in order to broaden the application of ethnomathematical approaches in classroom practice.

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