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Exploration Ethnomathematics in Traditional Games of Mancala in Africa and Congklak in Indonesia

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ABSTRACT

Purpose of the study: Study this aiming for explore draft ethnomathematics in game traditional Mancala in Africa and congklak in Indonesia use understand relatedness between culture and mathematics in context game.

Methodology: With use approach qualitative ethnography, research this collect data through observation participatory, interview in-depth, and documentation to Mancala players in Ghana and congklak in Sumatra, as well as educators at school basis. Research results show that second game this involving draft mathematics like pattern numbers, distribution strategy, operations count, and thinking logical and probable.

Main Findings: Experienced players show natural mathematical thinking through efficient strategies. While Mancala remains popular in Ghana, congklak is declining in Indonesia. Observations indicate traditional games have strong potential in culture-based math education. Thus, preservation and innovation are needed to integrate them contextually into learning.

Novelty/Originality of this study: The novelty of this research lies in the exploration of the concept of ethnomathematics in the games Mancala in Africa and congklak in Indonesia through a qualitative ethnographic approach, which has not been studied in depth.

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1. INTRODUCTION

Mathematics often considered as discipline rigid and separate science from culture . However , in reality, the concept mathematics can found in various aspect life society, including in game traditional [1], [2]. One of the branch the science that studies connection between culture and mathematics is ethnomathematics, which researches how concepts mathematical applied in activity daily a community, including game inherited tradition from generation to generation [3], [4]. Game traditional is part from inheritance culture that is not only functioning as entertainment, but also reflects values social, intellectual, and conceptual evolving mathematics in a society. Two games that have mark strong mathematics and culture is Mancala, which originates from Africa, and congklak, which is known widespread in Indonesia and other Southeast Asian countries . Both game This own similarity in mechanism games, namely use seed or small stones that are moved from one hole to hole other with rule certain [5], [6]. Apart from being entertainment, games th,is also trains skills think logical, calculation, strategy, and breakdown problem.

Mancala is known widespread in various African countries with various name variations and rules games, while congklak become game popular in Indonesia [5], [7]. Both game this no only depend on luck, but also strategy, patterns distribution, and calculation, which are no direct reflect draft mathematics used in a way passed down by society local.However, along with development technology and its popularity digital games, many game traditional start displaced and lacking favored by generations young [8], [9]. In fact, the game like mancala and congklak own potential big for utilized in education, especially in learning mathematics based on culture. Unfortunately, until moment this still a little research that explores how draft ethnomathematics contained in second game the as well as how public understand and pass it on.

Based on problem said , research this aiming for explore draft ethnomathematics that exists in game traditional mancala in Africa and congklak in Indonesia through approach qualitative ethnography [10], [11]. game this is in society. In addition, exploration this is also expected can give outlook about how mancala and congklak games can adapted in learning more mathematics contextual and interesting for generation young. With thus, research this no only contribute to documentation and preservation game traditional as part from identity culture, but also revealing how concepts mathematical in game this can utilized in context more education wide [12], [13].

Based on previous research that has been conducted, this study shows a gap with previous research. This study explores the game of mancala from Africa and congklak from Indonesia while the study conducted in 2023 discussed the game of galasin in Jakarta [14]. This study includes cross-cultural and comparative approaches between the two countries, and focuses on the study of ethnomathematics elements such as distribution patterns, playing strategies, and logistical thinking in the context of traditional games [15], [16]. While previous research was more limited to the visualization of formal geometric concepts such as gradients and vectors in one local game. The previous research conducted by Wikan Dewi Asriyani focused on exploring basic mathematical elements (addition, subtraction, data forms) from several traditional games in one local area. This shows that the first article has a stronger depth and breadth in cultural and mathematical ties, while the other two articles tend to be more specific and applicable to the local educational context [17], [18].

The gap is also very apparent from the research background. This article is based on concerns about the fading of traditional games due to the development of modern technology, and emphasizes the importance of preserving culture through the integration of games into contextual mathematics learning. Meanwhile, in the research conducted in 2023, although it also raised the theme of cultural preservation, it focused more on the learning needs in schools namely how traditional games can be used as a learning medium that is fun and relevant to students' daily lives [19]-[21]. The research in 2023 also saw games as a means of visualizing abstract concepts. Meanwhile, Wikan's article leads to a descriptive approach and strengthening local cultural identity in the learning process. Therefore, it can be concluded that the first article provides broader theoretical and practical contributions to the development of ethnomathematics.

Hence, from the gap analysis, this study offers a novelty in cross-cultural qualitative ethnographic approach that examines two traditional games, Mancala from Africa and Congklak from Indonesia, within an ethnomathematics framework [22]-[24]. Different from previous studies that generally focus on one local game descriptively, this study reveals the relationship between cultural values and mathematical concepts such as distribution patterns, arithmetic operations, and logical strategies that grow naturally from playing practices, while also offering a contribution to contextual, culture-based mathematics learning.

This study has important implications for education and cultural preservation. By exploring the mathematical elements in Mancala and Congklak games, this study shows that traditional games can be an effective contextual learning medium to hone students' logical and strategic thinking patterns. Culturally, this study also documents and elevates the intellectual value of traditional games as part of a cultural heritage that is relevant to modern education. These findings encourage the integration of a culture-based approach into the curriculum, as well as inspire educators to develop contextual, fun, and meaningful mathematics learning.

This research is urgently needed considering the increasing fading of traditional games due to the flow of digitalization and the lack of attention to the educational potential contained therein. In the midst of efforts to reform education to be more meaningful and contextual, the ethnomathematics approach is a strategic solution in bridging local culture and mathematics learning. This urgency is reinforced by the lack of cross-cultural studies that raise two games from different countries in one comparative ethnomathematics framework.

This study aims to explore and analyze the mathematical concepts contained in the traditional games of Mancala from Africa and Congklak from Indonesia through a qualitative ethnographic approach. Specifically, this study aims to uncover mathematical thinking patterns such as distribution, strategy, arithmetic operations, and logic that grow naturally in game practices, and examine the potential for integrating these games into more contextual and meaningful cultural-based mathematics learning for students.

2. RESEARCH METHOD

Study this apply design qualitative ethnography, which aims For explore connection between culture and concept mathematics in game Traditional Mancala and Congklak. Ethnography used Because allow researcher For

observe direct practice game in context each culture [25], [26]. Research This will done with observation participatory and interview deep to the community that plays and passes on game the.

Election subject study done with purposive sampling technique , namely choose individuals who have experience and knowledge deep about mancala and congklak games . Subject study this consists of from player traditional mancala in africa specifically from Ghana, then player traditional congklak in Indonesia which originates from from the Sumatra region, then educator or a math teacher at one of the school base [27], [28].

Data collection techniques in research this collected through a number of techniques, including observation participatory . Researcher will observe and participate direct in mancala and ongklak games in the community local as well as observation done for understand rule games, strategies used, as well pattern mathematics that appears in game. Collected data covers movement players, game strategies, and interaction social events that occur during game [29], [30]. Then technique further data collection interview, conducted to players and educators. Interview aiming for dig understanding public about draft mathematical in game as well as how game this inherited from generation to generation. The final data collection technique that is documentation, where researcher gather various reference related to mancala and congklak, both from books, journals, and history documents. Documentation also includes photos, videos and notes field from the observation and interview process.

Study this use guide observation for take notes pattern games, strategies and responses players, as well as guide interview related draft mathematical, perception players, and inheritance game . Notes field documenting results observation and interviews, supported by tools recorder and camera for data accuracy [31], [32]. Data analysis was performed through analysis thematic, covering data reduction , categorization and coding , as well as analysis interpretive linking findings with theory ethnomathematics. Validity findings reinforced with data triangulation, before arranged in report the ending that describes aspect mathematics and culture in mancala and congklak games.

Data analysis techniques in study this done with approach analysis thematic , which consists of from some stages like data reduction with selecting and summarizing data from results observations, interviews , and relevant documentation with research [33], [34]. Then categorization with grouping data based on theme main , such as draft mathematics in game, rules games, player strategies , and inheritance culture. Then do interpretative analysis with connect results observation and interview with theory ethnomathematics as well as draft relevant formal mathematics. Next data triangulation, with do data comparision from observation, interviews and documentation use painful validity findings study.

Study this started with stage preparation, including compilation design, permit research, identification subject, and instrument research [35]-[37]. At the stage data collection, carried out observation, interviews, and documentation mancala and congklak games. Data then analyzed through stage analysis, including transcription, identification draft mathematical, and triangulation. Finally, at the stage compilation report, results study arranged in form academic with recommendation for education mathematics and conservation culture.

3. RESULTS AND DISCUSSION

Based on results observation participatory and interview depth that is done to player traditional mancala in Ghana and congklak in Sumatra, found a number of findings the main thing that reveals relatedness between game traditional this with draft mathematics. Findings the covers pattern game and player strategy, concept applied mathematics in a way no aware by the player, as well as aspect inheritance culture game in public.

3.1. Game Patterns and Player Strategies

Observation show that both mancala and congklak own rule demanding game player for understand pattern distribution seeds and predict step opponent. In mancala, players using calculation strategy step for maximize amount seeds that can collected, while in congklak, player must consider which hole will chosen for ensure continuity game and earn profit maximum. This is show existence draft mathematics like pattern repetitive, probability strategies, and thinking logical in games.

Mancala and congklak games demand player for understand pattern distribution seeds and predict step opponent. In mancala, players using calculation strategy step for maximize amount seeds that can collected, while in congklak, election the right hole become key for guard continuity game. This is show existence implementation draft mathematics like pattern repetitive, probability strategies, and thinking logical.

Tabel 1. Game Patterns and Player Strategies

Game	Strategies used	Draft the mathematics involved
Mancala	Count optimal steps for maximize collected seeds	Calculation combinatorial, probability strategy, thinking logical
Congklak	Choose holes that allow continuation game longer and optimize acquisition seed	Distribution pattern numbers, probability, strategy optimization

From the results interview, player experienced tend have more strategy efficient compared to player beginners. They in a way instinctive implementing strategies based on patterns mathematics although without understanding explicit about theory the underlying mathematics.

3.2. Concept Mathematics in Game

Player traditional generally no realize that they apply draft mathematics in game. However, in in practice, they in a way experience use skills calculation basic, pattern numbers, and optimization strategies. From the results interview with players and educators, found that even though the players traditional no in a way explicit realize existence element mathematics in games, they in a way experience apply draft calculation basic, pattern numbers, and optimization strategies in every his steps. The player who is more experienced tend have a better playing strategy efficient, shows existence pattern think developing mathematics in a way experience in game this.

Tabel 2. Concept Mathematics in Game

Draft Mathematics	Implementation in mancala	Implementation in congklak
Number Pattern	Distribution seed follow pattern certain	Every hole own amount the changing seed in a way systematic
Operation Count	Player count step for reach hole certain	Player anticipate amount the seeds that will end up in a hole certain
Probability Strategy	Choose steps that have opportunity highest for win	Adjust strategy based on possibility step against

3.3. Inheritance Game in Society

Mancala and congklak games inherited in a way hereditary through interaction social in family and community. In Ghana, mancala is still often played by children as part from activity everyday, while in Indonesia, congklak start reduce its popularity and more often played in cultural events or in the environment school.

Interview results also revealed that mancala and congklak games inherited in a way hereditary through interaction social in family and community . In Ghana, mancala is still often played by children as part from game everyday, while in Indonesia, congklak start reduce its popularity and more often played in cultural events or in the environment school. Educators interviewed highlight that game this can become tool help in learning more mathematics contextual and based culture.

Tabel 3. Inheritance Game in Society

Aspect Inheritance	Mancala in Ghana	Congklak in Indonesia
Inheritance Culture	Played by children in daily life	More often played in cultural and school events
Role in Education	Used as tool for teach logic and strategy	Potential become tool learning mathematics based on culture

Interview with educator show that game this own potential for used in learning mathematics contextual, which can help student understand draft abstract through practice direct.

3.4. Documentation and Data Validation

Analysis triangulation is done with compare results observation, interviews, and documentation show that draft mathematics in mancala and congklak can integrated in learning, especially in material like pattern numbers, operations counting, and thinking strategies logical. In addition, the documentation history show that game this has there is during centuries and has mark potential educational if developed more carry on in the world of education.

For ensure validity findings, research this use triangulation of data with compare results observation, interviews, and documentation. Documentation history show that mancala and congklak games has there is during centuries and has mark potential educational if developed in the world of education.

Tabel 4. Documentation and Data validation

Data source	Consistent findings
Observation	Distribution pattern seeds and game strategy show relatedness with draft mathematics
Interview	Players and educators confess the existence of a thinking strategy logical in game
Documentation	History of the game reflect sustainability inheritance culture and potential educative

With findings this, can concluded that mancala and congklak no only just game traditional, but also has potential big in learning mathematics. Game integration this in education can give experience learn more interesting and contextual for student.

Based on the findings of this study, then with previous research that has been conducted. So this study creates a research gap from various research perspectives. As in previous research conducted in 2024, which focused on the characteristics of junior high school teachers' beliefs in developing students' numeracy skills through ethnomathematics-based numeracy learning [38]-[40]. The main findings show that the majority of teachers view ethnomathematics-based numeracy learning in the semi-realistic-mechanistic (SRM) category, where changes in teachers' views on numeracy shift to being more dominantly realistic (DR) as teaching experience increases. This study shows that strengthening culture-based numeracy is closely related to teachers' internal beliefs and perspectives, both on the concept of numeracy, the role of ethnomathematics, and the learning approaches used. On the other hand, this study takes a different focus, namely exploring the concept of ethnomathematics that is clearly present in the traditional games of Mancala from Africa and Congklak from Indonesia [41], [42]. The findings of this study indicate that mathematical elements such as number distribution patterns, arithmetic operations, probabilistic strategies, and logical thinking develop naturally in traditional game practices without the players realizing it. In addition, this study reveals differences in the process of cultural inheritance, where Mancala is still actively played in the daily lives of children in Ghana, while Congklak in Indonesia is starting to experience a decline in popularity, although it is still maintained in cultural and educational contexts [43]-[45].

The most fundamental gap between the two studies lies in the focus of the findings. The first study highlights more aspects of teachers' internal beliefs in building culture-based numeracy, which are analyzed based on the level of teaching experience and the orientation of the mechanistic or realistic approach [46], [47]. While the second study focuses on empirical evidence of the existence of mathematical concepts in real cultural practices through direct observation and interviews with traditional players and teachers. Thus, the first study produces a picture of the importance of a paradigm shift in teachers' perceptions of ethnomathematics-based numeracy learning, while the second study presents concrete evidence that local cultural sources in this case traditional games contain rich mathematical potential to be integrated into learning [48]-[50].

In addition, there is also a gap in the methodological approach and its practical output. The first study used a combination of quantitative and qualitative approaches with a structured questionnaire instrument to uncover the dimensions of teacher beliefs, while the second study used an ethnographic qualitative approach with triangulation of observation data, interviews, and documentation to directly uncover the relationship between culture and mathematics [51]-[53]. The practical implications of the two studies are also different; the first study leads to the need to develop teacher competency improvement programs to view numeracy more contextually based on culture, while the second study encourages learning innovation by integrating traditional games as contextual and interesting mathematics learning media [54], [55].

Thus, from the overall analysis, it can be concluded that previous studies have contributed to strengthening the psychological aspects and teachers' perceptions of the importance of culture-based numeracy, while this study enriches the realm of empirical practice by showing the potential of cultural sources as concrete mathematical teaching materials [56]-[58]. Thus, the gap between the two studies is not only in the focus of findings and methods, but also in the direction of contribution to the development of ethnomathematics-based learning, namely between building teacher readiness and providing real cultural sources for educational innovation.

From the gap analysis, this study offers significant innovation in the field of ethnomathematics and culture-based mathematics education [59], [60]. Different from previous studies that focused more on teachers' perceptions of ethnomathematics-based numeracy or limited exploration of one local culture, this study carries a cross-cultural qualitative ethnographic approach by exploring two traditional games from two different regions, namely Mancala from Africa and Congklak from Indonesia. This approach enriches ethnomathematics studies by comparing two forms of traditional games that, although geographically different, show similarities in mathematical structure in their practices. This study offers innovation with a direct contextual approach to cultural practices, revealing how mathematical elements such as number distribution patterns, arithmetic operations, probability strategies, and logic develop naturally in traditional games without formal educational intervention. In addition to showing the potential of traditional games as authentic contextual mathematics learning resources, this study also highlights the importance of cultural preservation in modern education. Different from previous studies that only use games as visualization media, this study shows that traditional games have deep intellectual value and are relevant for learning innovation. With cross-cultural exploration and focus on contextual integration, this research strengthens the position of ethnomathematics as a bridge between local cultural heritage and modern mathematics learning.

This research has important implications for the world of education, especially in the development of culture-based mathematics learning. By proving that traditional games such as Mancala and Congklak contain mathematical concepts such as distribution patterns, arithmetic operations, probability strategies, and logical thinking, this research opens up opportunities for teachers to integrate local cultural elements into mathematics learning that is more contextual, interesting, and meaningful for students. This can help improve the understanding of abstract mathematical concepts through real experiences that are relevant to students' daily lives. In addition,

from a cultural perspective, this research contributes to the preservation of traditional games that are increasingly marginalized in the digital era, by proposing an integrative approach in the education curriculum. Another implication is to encourage innovation in cross-cultural ethnomathematics-based learning to enrich students' insights into cultural diversity and the universality of mathematical concepts.

Although this study makes important contributions, there are several limitations that need to be noted. First, the scope of this study is limited to the exploration of two traditional games, namely Mancala from Ghana and Congklak from Indonesia, so the results do not cover the diversity of other forms of traditional games in various regions or countries that may have different mathematical structures. Second, the qualitative approach used, although allowing for in-depth exploration, does not provide quantitative generalization to a wider population. Third, this study focuses on the documentation and analysis of mathematical elements in game practices, but has not directly tested the effectiveness of integrating these games in the context of formal classroom learning. In addition, differences in socio-cultural conditions and the level of popularity of games in each country may also affect the implementation of the results of this study more widely. Therefore, further research is needed with a wider cultural scope and an experimental approach to test the concrete impact of integrating traditional games in improving students' mathematics learning outcomes.

Based on the research results, it is recommended to strengthen the role of traditional players and educators through training to understand and optimize mathematical elements in Mancala and Congklak games as contextual learning media. For the research object, innovation is needed in the form of adapting the game into a module or curriculum-based teaching material to maintain cultural authenticity while expanding its educational function at various levels of education. For further research, experimental studies in the classroom are recommended to test the impact of integrating traditional games on students' logical thinking, numeracy, and problem-solving skills, as well as exploring other traditional games to enrich culture-based learning resources.

4. CONCLUSION

Based on observation, interviews, and documentation, games traditional mancala in Ghana and congklak in Indonesia have relatedness close with draft mathematics, especially in calculation, distribution strategy, and problem solving problem. Game this practice pattern think logical, probability strategies, and patterns numbers, although player often no realize element mathematically. In Ghana, mancala is still active played, while in Indonesia, Congklak start reduce its popularity, even though still guarded in context culture and education. Analysis triangulation show that game this own potential big in learning mathematics based on culture. Therefore that, efforts preservation and integration in education need done so that the game this can become tool help contextual and interesting learning for student. Further research is suggested to test the implementation of Mancala and Congklak in mathematics learning through experimental studies, develop digital adaptations based on local culture, expand the study to other traditional games, and conduct longitudinal studies to measure the long-term impact on student learning outcomes and character.

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