



Developing Hypothetical Learning Trajectory of Probability Through Ethnomathematics Using the Congklak Game: Exploring Local Wisdom

By:

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Abstrak — Penelitian ini bertujuan untuk mengembangkan Hypothetical Learning Trajectory (HLT) dalam pembelajaran peluang melalui pendekatan etnomatematika menggunakan permainan tradisional congklak. Pembelajaran berbasis budaya lokal diyakini dapat meningkatkan pemahaman konsep peluang secara lebih kontekstual dan bermakna. Metode penelitian yang digunakan adalah deskriptif kualitatif dengan pendekatan etnografi. Hasil penelitian menunjukkan bahwa pembelajaran peluang dengan menggunakan congklak sebagai konteks dapat meningkatkan keterlibatan siswa, membantu mereka memahami konsep ruang sampel, titik sampel, serta peluang teoretis dan empiris secara lebih sistematis. Temuan ini menegaskan bahwa integrasi etnomatematika dalam pembelajaran peluang tidak hanya meningkatkan pemahaman matematis siswa, tetapi juga berkontribusi dalam pelestarian budaya lokal. Oleh karena itu, pendekatan ini direkomendasikan untuk diterapkan dalam pembelajaran matematika, khususnya pada materi peluang.

Kata kunci: Lintasan Belajar, Peluang, Etnomatematika, Pendidikan Matematika Realistik, Kearifan Lokal

Abstract — This study aims to develop a Hypothetical Learning Trajectory (HLT) in learning probability through an ethnomathematics approach using the traditional game congklak. Local culture-based learning is believed to improve the understanding of the concept of chance in a more contextual and meaningful way. The research method used was descriptive qualitative with an ethnographic approach. The results showed that learning probability by using congklak as a context can increase student engagement, help them understand the concepts of sample space, sample points, and theoretical and empirical probability more systematically. This finding confirms that the integration of ethnomathematics in learning probability not only improves students' mathematical understanding, but also contributes to the preservation of local culture. Therefore, this approach is recommended to be applied in mathematics learning, especially on chance materials.

Keywords: Hypothetical Learning Trajectory, Probability, Ethnomathematics, Realistic Mathematics Education, Local Wisdom

Introduction

Probability is one of the materials in mathematics learning that aims to predict an event. Understanding this concept is very important because it helps learners in honing their analytical skills and data-based decision making. By understanding probability, learners can assess the likelihood of an event occurring, thus being able to make more logical and informed decisions in various aspects of daily life, such as financial planning, game strategy, and decision making in

uncertain situations. The concept of chance material was originally inspired by gambling players or individuals who often engage in games with the aim of winning the game. Despite its origins in gambling games, chance has now developed into a widely applied branch of mathematics. For example, this concept is used in various fields such as industry, science, and the business world. (Isrok'atun, 2010).

Probability material has been taught to students from junior high school to high school. However,

learning probability in schools encounters various challenges. Research conducted by Yustiana et al. (2018) revealed that students experience difficulties in learning mathematics, especially in probability material. This material is part of the mathematics learning given to students in grade VIII of junior high school (Bennu & Tandiyuk, 2020). Students' difficulties in understanding the material include a lack of understanding of the concept of chance, errors in applying formulas, and lack of participation in learning due to teaching methods that are still teacher-centered (Fadzilah, 2016; Nengsih & Septia, 2017). In addition, learning that is able to motivate students, attract interest in learning, interactive, is a challenge in teaching mathematics (Septy et al., 2015).

One solution that can be applied in learning mathematics to make it more meaningful is through the integration of local culture. According to Bishop (1994b), mathematics is a form of culture that has been integrated into various aspects of people's lives wherever they are. If associated with culture, learning mathematics becomes more meaningful because students can understand mathematical concepts in a context that is close to their lives, making it easier to understand. Therefore, educational institutions in Indonesia can adopt a local wisdom-based education model. Local wisdom is a cultural heritage from the past that should continue to be used as a guide in life. Suastra (2017) also states that local wisdom is defined as the truth that has become a tradition. Local wisdom-based education emphasizes learning based on cultural values. In this case, it is necessary to design learning based on local wisdom and adapted to the right context (Pedro et al., 2018).

Mathematics and culture are closely related. The relationship between the two can be linked in a particular context through an ethnomathematics approach (Albanese & Perales, 2015). Ethnomathematics aims to understand the relationship between mathematics and culture, with the hope that students and the general public will easily understand it, so that it can make mathematics easier to learn (Abdullah, 2017). Through the application of ethnomathematics, mathematics education is expected to help students understand mathematical concepts while recognizing their own culture. In addition, this application makes it easier for educators to instill cultural values in students, so that cultural values that are part of the nation's character can be embedded from an early age. (Wahyuni et al., 2013).

A strategy that can be applied by teachers in teaching ethnomathematics-based mathematics is

to use the Realistic Mathematics Education (RME) approach, which began to be developed in the Netherlands in the 1970s. This theory was first coined by Hans Freudenthal, with the main concept that "mathematics is a human activity" (Shanty, 2016; Prahmana et al., 2012). RME is a learning approach that focuses on the process of rediscovery and introduction of concepts through contextual problems or situations in everyday life, so that they can build understanding independently (Wijaya & Marlinda, 2018; Lisnani & Asmaruddin, 2018). This approach helps teachers relate learning materials to the context of real life, while encouraging them to connect the knowledge they already have with the context of everyday life. Thus, learning becomes more meaningful for students.

The context of everyday life and local wisdom can help learners more easily understand the concepts taught in a more interesting way, one of which is through traditional games. Traditional games are an integral part of Indonesia's cultural heritage. In addition to serving as fun entertainment, traditional games can also be utilized as an effective means of learning various mathematical concepts. One of the relevant traditional games to be studied in the context of learning mathematics on chance material is congklak. By using the traditional game of congklak in mathematics learning, it is expected to increase students' involvement and enthusiasm when understanding the concept of chance. In addition, this approach also plays a role in honing logical thinking skills, analytical, and decision-making skills (Marsyanda, 2023). Another example of a traditional game that can be used for math learning is the snake dragon game. The game reflects local wisdom that is used as inspiration in learning mathematics, especially on chance materials (Nurhikmayati & Sunendar, 2020; Hartono & Nursyahidah, 2021; Nursyahidah & Albab, 2021).

Hypothetical Learning Trajectory (HLT) is one of the tools that help teachers in learning strategies. In this case, HLT can be used as a framework in designing instructional tasks that consider learners' initial understanding and their way of thinking, so that the concept of probability can be learned more systematically and meaningfully. HLT is designed to help learners understand mathematics learning concepts. HLT is an important aspect for teachers in creating meaningful and structured learning because it considers learners' prior knowledge. In addition, HLT also plays a role in helping teachers design learning that is in accordance with the thinking patterns and characteristics of students in the classroom (Rezky, 2019). Therefore,

understanding HLT is very important for teachers, because by understanding this concept, teachers can develop learning models that pay attention to the characteristics of students based on existing theories and their initial abilities. Thus, learners' needs can be met, and their potential will be developed through appropriate learning design.

The combination of Congklak, Ethnomathematics, and HLT in learning probability can be an effective solution to overcome the challenges of learning probability while preserving cultural heritage. Congklak as a traditional game is not only entertaining but also involves strategies and calculations related to the concept of chance. With the ethnomathematics approach, learners can understand that mathematics is not just an abstract theory, but part of a culture that has long been applied in everyday life. Meanwhile, HLT plays a role in designing learning in accordance with the flow of students' thinking in understanding learning concepts (Surya, 2018), so that the concept of chance can be understood more systematically. Through the integration of these three aspects, learning becomes more meaningful, interesting, and contextual while at the same time can foster appreciation for local cultural heritage.

Based on the background that has been presented, this article is part of the writing that focuses on developing students' learning trajectories in understanding the concept of chance through the game of congklak. In addition, the purpose of this article is to explore the integration of Ethnomathematics in designing culturally relevant mathematics learning. The design of HLT has an important role in identifying students' mindset, so that it can help them overcome difficulties in learning probability systematically and contextually.

Result and Discussion

The initial stage in design research is preliminary design, which includes several activities, such as conducting a literature review, designing learning trajectories, and validating learning tools before they are applied to students (Akker et al., 2006). At this stage, the literature review was conducted by collecting various information relevant to the research, including probability materials from literature and school books. In addition, the literature review was also used to gain an understanding of Indonesian Realistic Mathematics Education and design research, which became the basis for designing the probability learning strategy.

Methods

The research method applied is design research. According to Gravemeijer and Van Eerde (2009), design research is a research approach that aims to develop local instruction theory (LIT) to improve learning effectiveness. This approach consists of three main stages, namely preliminary design, design experiment, and retrospective analysis.

The first stage, preliminary design, includes various activities carried out by researchers, such as literature review related to the context, materials, and research methods. This study was used as a foundation in developing the HLT, which consists of a series of activities, learning objectives, and hypotheses regarding student understanding. The second stage, the design experiment, involved testing the HLT on a small group of students with diverse ability levels. Data collection in this research was conducted through observation and literature review. In this article, the researcher focuses on the first stage of design research, which is preliminary design. The main activity discussed in this article is the preparation of HLT with the context of congklak game to teach the concept of chance.

This research applies a descriptive qualitative method with an ethnographic approach, considering that the main focus of this research is rooted in Indonesian cultural phenomena, especially traditional games. The game of congklak was chosen as the object of study because it can be played by everyone and has a connection with the concept of chance. In addition, this study aims to explore the relationship between the congklak game and chance material in more depth. Data analysis in this study was conducted qualitatively by compiling and describing the findings based on word

This research produced HLT in learning probability using ethnomathematics-based congklak game. The developed HLT consists of four main activities, namely: (1) determining empirical odds through observation of the congklak game, (2) determining theoretical odds based on game analysis, (3) determining sample space and sample points, and (4) solving contextual problems related to odds. The HLT structure in this study is analogous to the iceberg model, where the part that appears on the surface describes the final understanding of the learners, which is the result of gradual development through the basic concepts that have been built previously. The following iceberg image is used to build the HLT in this study.

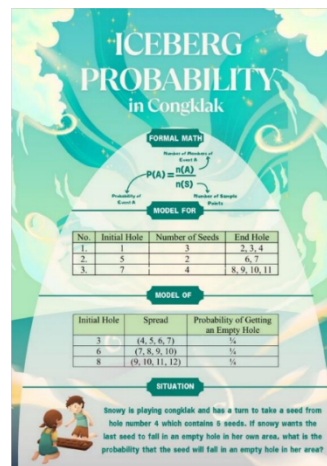


Figure 1. Iceberg Probability in Congklak Game

The results showed that students understand the concept of odds more easily when the context used is close to their experience. With the game of congklak, students can directly observe patterns and strategies related to probability, thus improving their understanding of the concepts of sample space, sample point, and theoretical probability. This learning also supports the Indonesian Realistic Mathematics Education approach which emphasizes the use of real contexts in understanding mathematical concepts.

1. Activity 1: Determining Empirical Chance

In the first stage, students are given the probability to observe a game of congklak with the aim of understanding empirical odds. They recorded the number of events that occurred during the game and counted the total number of attempts made. Through this observation, most students were able to identify patterns in the game and understand how the odds can be calculated based on the empirical data obtained. However, some students had difficulty in understanding the concept of frequency of occurrence and its application in the empirical odds formula. To overcome this challenge, the teacher provided additional guidance by explaining the relationship between the number of events and the number of trials conducted.

In this activity, students observed the game of congklak and recorded the number of events that appeared as well as the total number of trials. The observation results showed that most students could identify the number of rounds of the game and how each player gets a chance to play. However, some students had difficulty in understanding the concepts of frequency of occurrence and empirical probability mathematically.

2. Activity 2: Determining Theoretical Odds

At this stage, students are invited to analyze the game of congklak from the perspective of theoretical probability. They record the number of beans left in the barn after the game is over and compare it with the number of rounds that occurred. Students are asked to determine the probability of each possibility based on the rules of the game they have observed. Although some students had difficulty in writing down the theoretical probability mathematically, they were finally able to understand this concept after receiving guidance from the teacher. The teacher helps them see the relationship between the sample space and the probability of events, so that they can develop a deeper understanding of theoretical odds.

At this stage, students are invited to connect the game of congklak with the concept of theoretical chance. Students are asked to record the number of seeds in the barn after the game is over and compare between the number of rounds and the final result of the game. Some students had difficulty in writing the theoretical odds correctly, so the teacher provided additional guidance to help them understand the relationship between sample space and probability of occurrence.

3. Activity 3: Determining Sample Space And Sample Points

In this activity, students are asked to determine the sample space and sample points based on the observation of the congklak game. They initially experience confusion in distinguishing between sample space and sample points, especially in understanding how the possible outcomes of the game can be represented systematically. However, with the

help of class discussions and concrete examples, students began to realize that the sample space includes all possible outcomes of the game, while the sample point refers to each specific outcome within that sample space. This activity helps them understand that the concept of chance is closely related to mapping the possible events that can occur in an experiment.

In this activity, students determine the sample space and sample points based on observations of the game of congklak. The results of the analysis show that students understand this concept more easily when given concrete examples from the game. Some students initially thought that the sample space only consisted of the number of steps in the game, but after further discussion, they began to understand that the sample space includes all possible outcomes of the congklak game.

4. Activity 4: Solving Contextual Problems

In the last stage, students are given probability-based problems in everyday life related to the concepts they have learned before. One example given is determining the probability of getting a prize in a lottery-based game. Using their understanding of empirical and theoretical odds, students try to solve the problem by applying the concepts they have learned. The analysis showed that students who had understood the relationship between sample space, sample points, and probability could solve the problem more accurately. However, some students still had difficulty in distinguishing between empirical and theoretical probabilities, so the teacher provided additional examples to help them clarify the concepts.

In the last activity, students are given problems that relate the odds to everyday situations, such as the chance of getting a prize in a game. The results showed that students who had understood the concept of theoretical probability were more able to solve contextual problems correctly. However, some students still had difficulty in distinguishing between empirical and theoretical probability, so the teacher needed to provide additional examples to clarify the concept.

Conclusion

The results of this study indicate that the use of congklak game as a context in learning probability can improve students' understanding of the concept of probability. Students are more motivated and active in learning, and more easily

understand abstract concepts in probability through direct exploration in traditional games. This ethnomathematics-based learning also contributes to preserving local wisdom while improving students' mathematical understanding. The application of PMRI approach in this learning design helps students to connect math with their real experience. By using the congklak game, students can actively build their own understanding of chance and apply it in everyday situations. Therefore, this ethnomathematics-based approach is recommended to be used in learning probability at school.

Based on the research findings, several things can be recommended for further development. In learning practice, the use of congklak game has been proven to improve students' understanding of odds. Therefore, teachers are advised to continue integrating traditional games in the learning process to create a more meaningful and interesting learning experience. In addition, training for teachers on the Indonesian Realistic Mathematics Learning (PMRI) approach can help in optimizing the application of this method in the classroom.

In terms of theory development, the results of this study can be the basis for designing a broader ethnomathematics-based learning model, especially in the concepts of probability and statistics. This approach can also be considered in the development of a more contextualized curriculum, where traditional games are used as a tool in explaining abstract mathematical concepts. In this way, math can be taught in a more relevant and interesting way for students.

For further research, it is recommended that similar experiments be conducted at different levels of education to test the effectiveness of this approach at different levels. In addition, the exploration of other traditional games such as gasing or egrang can provide new insights into how the concept of chance can be taught through various cultural contexts. The integration of technology in learning can also be the focus of future research, for example by developing a digital simulation of the game congklak to provide a more interactive and immersive learning experience.

With these suggestions, it is hoped that traditional game-based probability learning can continue to be developed and improved in various aspects of education, thus helping students understand mathematical concepts in a more natural and enjoyable way.

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