Teaching Probability using Snakes and Ladders Games in Middle School

Ririn Suparti Kurnianingsih[1], Ratu Ilma Indra Putri[1] and Yusuf Hartono[1]

[1]Mathematics Education Department, Universitas Sriwijaya, Palembang, Indonesia

Abstract: This study aimed to support students' understanding in probability using snake and ladders' game as context. We used design research as approach then designed three learning activities using Pendidikan Matematika Realistics Indonesia (PMRI), a Hyphotetical Learning Trajectory (HLT) was develop and a set of activities using snake and ladders game as context. There are 33 students of SMPN 55 Palembang were participated in teaching experiment. The theoretical development is driven by an iterative process of designing instructional activities, performing teaching experiments and conducting retrospective analysis in order to contribute to Local Instruction Theory (LIT) to support students' problems solving on probability. Retrospective analysis of teaching experiment showed that using snakes and ladders game context can support students understanding on the Probability materials.

1   INTRODUCTION

Probability is a sub-topic of the discussion of the mathematical sciences of probability and statistics (Sina, 2011). Probabilities represent real-life mathematics and students need to explore the process of probability, probabilities also relate to many subjects in mathematics, especially counting and geometry (Taylor, 2010). De Walle (2008) also states that the concepts of realistic probabilities require a lot of development before children are ready to build formal ideas about the probability of future events. It is expected to occur when children consider and discuss with their peers.

The use of general context also influences students' difficulties in developing correct intuition about basic ideas about probabilities (Huerta, 2011; Garfield and Ahlgren, 2006; Sharma, 2006; Azhar, 2011). Context is also closely related to students' personalities such as traditional children's games (Putri, 2010). The importance of using context in learning materials should begin with situations known to students (Putri, 2012). In this study, snake and ladder games were chosen as context to help students in learning probabilities. The snake and ladder game provides an activity in which probabilities and possibilities can become experiences, in situations where the probability of an event is not immediately known (Melrose, 2007). According to Lalos, Lazarinis and Kanellopoulos (2008) snake and ladder games are an educational based game. In games, education is given through practice or practical learning (learning by doing), indirectly by educating humans through what they do in the game (Purnanindya, 2012).

Pendidikan Matematika Realistik Indonesia (PMRI) is a mathematical learning approach that can be used in this learning. PMRI is an adaptation of RME (Realistic Mathematics Education) which is a learning approach that will lead students to understand mathematical concepts by constructing themselves through prior knowledge by discovering the concepts themselves, so that student learning is expected to be meaningful. In other words, mathematics must be close to students and related to everyday life, and also mathematics as human activities so students must be given the opportunity to do learning activities in every topic in mathematics (Zulkardi & Putri, 2010; Putri, 2011). Students as center in learning is expected to create a pleasant atmosphere and the creation of activities and creativity of students (Putri, 2009).

Based on the illustration, the researchers designed the learning probability using snake and ladder games using PMRI approach for the seventh grade students. Then, it was designed by using Hypothetical Learning Trajectory (HLT) which contains a series of activities

to help students understand probabilities. The purpose of this research was to obtain the learning trajectory in probability learning using snakes and ladders games using PMRI approach and to determine the role of snakes and ladders games in learning probabilities.

2 LITERATURE REVIEW

2.1 Pendidikan Matematika Realistik Indonesia (PMRI)

PMRI is an adaptation of Realistic Mathematics Education (RME), a learning theory developed in the Netherlands since the 1970s by Hans Freudhental. Two important views from Freudenthal are: (1) mathematics must be connected with reality and (2) mathematics as human activity (Zulkardi & Putri, 2010). Gravemeijer (1994) states that the role of a teacher must change from a validator (stating whether the student's work and answers are right or wrong), being a person who acts as a mentor who appreciates each student's contribution (work). The main principles of PMRI are as follows (Gravemeijer, 1994; Zulkardi, 2002; Zulkardi & Putri, 2010):

a. Guided reinvention and progressive mathematizing

Guided discovery and progressive mathematics can mean that students are given the opportunity to experience the same process when mathematics is found. The teacher guides students to move from one level to another level of mathematical thinking.

b. Didactical phenomenology

Situations that contain the phenomena that are used as material and application areas in teaching mathematics must depart from the real conditions of students before reaching the formal mathematics level.

c. Self-developed models

The principle of model development has a very important role for students. The role of the principle of the development of the model itself is to bridge students from real or concrete situations to abstract situations, or from the informal stage to the formal stage of mathematics. This means that students make their own models in solving problems from situations that are close to the nature of students, for example the use of the context of snakes and ladders games that are involved in learning mathematics to find concepts in the material probabilities for an event.

The principles of PMRI above can be explained more broadly through their characteristics. The five characteristics of PMRI (Zulkardi, 2002; Zulkardi, 2005; Zulkardi & Putri, 2010): (1) Use of contexts for phenomenologist exploration. (2) Use of models for mathematical concept construction'. (3) Use of students' creations and contributions. (4) Interactivity. (5) Intertwining mathematics concepts, aspects, and units.

2.2 Probability

There are 4 competencies in the subject matter of probability, namely: understanding randomness, sample space, comparing and measuring probabilities, and understanding correlations or relationships between events (Bryant & Nunes, 2012). According to Coladarci (2011: 175), probability theory is the possibility of certain events occurring. The possibility of the emergence of the front side of throwing a coin as much as once is 0.5. Because there are only two possible outcomes when throwing a coin. Thus an probability is a comparison that is between 0-1 denoted by p. The chance of an event A is the result of the number of sample points for event A with the number of members of the event sample room A, formulated as Equation (1).

$$P(A) = n(A)/n(S) \qquad (1)$$

2.3 Snakes and Ladders Games

The snakes and ladders games is a board game for kids that is played by two or more people. The board of snakes and ladders is divided into small boxes and some boxes are drawn by a number of "ladders" or "snakes" that connect them to other boxes (Yumarlin, 2013). The snakes and ladders games is played on a board with a 10x10 grid, a sequence number in a zigzag pattern from 1 (beginning, in the lower left corner) to 100 (end, in the top left corner). At various locations on the board are snakes and ladders placed, each or connecting a pair of boxes. All players start outside the board and take turns rolling the dice and moving according to the dice that appears. If the settlement moves at the foot of the ladder, then go straight up. Also, if you move above the snake's head, you are forced to slide to the snake's tail to the previous square. there is no consequence of landing on a ladder or snake tail. Snakes and stairs are one way of mathematical parts, this is called a directed graph. The first players to reach the 100 box win (Berry, 2012; Connors & Glass, 2014). This game was created in 1870. There is no standard board game in snakes and ladders, so everyone can create the

board size of a snakes and ladders games, with the number of boxes, snakes and stairs as desired (Yumarlin, 2013).

The game of snakes and ladders provides an activity in which opportunities and possibilities can be experiences, in situations where the probability of events is not immediately clear (Melrose, 2007). In the snakes and ladders games, students can use game boards and dice to determine opportunities. On board games there are snakes and ladders, and dice that can provide experience of opportunities and possibilities in opportunities. This game is an interesting application of pure mathematical works (Melrose, 2007).

3 METHODOLOGY

In this study, researchers used design research methods. Design research aims to develop Local Instructional Theory (LIT) in collaboration with researchers and teachers to improve the quality of learning (Gravemeijer and van Eerde, 2009). According to Gravemeijer and Cobb (2006: 19-43), the design and development process in design research includes three stages, namely: preparing for the experiment, design experiment, and retrospective analysis.

The cyclic process in the design research is carried out to get the learning trajectory. The learning trajectory is the result of the revision of the learning design that was tested on the material under study. This research was carried out in class VII of SMP N 55 Palembang, the first cycle was carried out with 6 students, and in the second cycle with 33 students. Data collection was done through several things such as based on the results of the pre-test and post-test, observation, video recording, student work and interviews were analyzed to improve HLT. Then the designed HLT is compared with the actual learning path of students to do retrospective analysis. Analysis is carried out by researchers and mentors to improve their reliability and validity.

4 RESULT AND DISCUSSION

This learning was designed to produce learning trajectory using snakes and ladders games by PMRI approach to help students understand probabilities and to determine the role of snakes and ladders games in probabilities learning. We will discuss the results

of experimental learning in the second cycle involving 33 students.

Activity 1: Using Tables, Tree Diagrams, Registering, and Cartesian Diagrams (Determining how to present all the events that occur and the chance of an event).

The learning process begins the same as with previous meetings, greetings, checking student attendance and apperception. Apperception is done by interacting between the model teacher and students through several questions posed by the model teacher regarding previous learning. Followed by the teacher conveying the learning objectives and providing motivation in learning the material today. Students sit based on groups that have been formed before. Before starting a group discussion, students are asked to pay attention to the learning video first, after which the teacher informs them that the time given for discussion is 40 minutes. Furthermore students are welcome to start with their respective groups.

Activity 1, learning was starts with students reading the problem and writing down the information needed from the problem. Students are given several ways to present the sample space. So students can choose how to present a sample space which they think is easy for them to understand. There are 4 ways to present the sample space, namely: how to register, using tables, tree diagrams and cartesian diagrams. Then the students play a snake ladder game that is found in activity 1, in this activity students are asked to determine the sample space between the snake and ladder game boards.

Figure 1: Board game for snakes and ladders in activity 1.

After the game is finished, students read the problem first and continue by writing down some information about the problem. This activity aims to direct students to determine Probabilities for an event. First the students write down the number of possibilities of the dice and the snakes and ladder game board. Then students can determine the overall value by multiplying the number of steps in the snakes and ladder game board (36) with the number of dice (6). Next the students compare the number of

stairs in the snakes and ladder game board with the many steps in the game board. Then students make conclusions about the probability of an event.

Figure 2: Conclusion of student activity 1.

Based on the students' answers to the conclusions (Figure 2), it can be seen that students begin to get used to drawing conclusions, even though only by using words they understand. Students already understand how to determine the probability of an event and its application. This can be seen through additional questions given at the end of activity 1 (Figure 3).

Figure 3: Student answers about additional activities 1.

Observer: Where did you get 3/10?
Students: 3 are chocolate-book, continue to compare with all of them 5 candies, 3 chocolates and 2 wafers added to 10. So it can be 3/10 or 0.3.

From Figure 3, students mistakenly determine the sample space. So that the amount of candy, chocolate and wafers should be added, but in their answers multiplying to get the sample space. Although the answer is wrong, it can be seen in the picture that students understand in determining the probability of an event. The following are the students' answers to the last problem in activity 1. Each group can finish correctly.

5 CONCLUSSION

Based on the results of research and discussion, it can be concluded that the learning trajectory which was obtained in this study is students can use the multiplication method in determining the number of samples. Then students determine the probability of an event through snake and ladder games. In addition, the results showed that the use of snakes and ladders games in learning probability materials have a role to help students in comprehening the probabilities.

REFERENCES

Azhar, E., 2011. Pengembangan perangkat pembelajaran teori peluang berbasis rme untuk meningkatkan pemahaman, penalaran, dan komunikasi matematik siswa SLTA. *Prosiding Seminar Nasional Matematika dan Pendidikan Matematika*, Yogyakarta: UNY.

Berry, N., 2012. *Mathematical analysis of snakes and ladders*, Seatle: Data Genetics.

Bryant, P., & Nunes, T., 2012. *Children's Understanding of Probability,* University of Oxford. London: Nuffield Foundation.

Coladarci, T., Casey., Minium., & Clarke, 2011. *Fundamentals of statistical reasoning in education 3rd Edition,* New York: John Wiley & Sons. Inc.

Connors, Darcie., & Glass, Darren, 2014. Chutes and ladders with large spinners. *The College Mathematics Journal,* 45(4).

De Walle, J. A., 2008. *Matematika Sekolah Dasar dan Menengah: Pengembangan Pengajaran Jilid 2,* Jakarta: Erlangga.

Garfield, J., & Ahlgren, A., 2006. Difficulties in learning basic concepts in probability and statistic. *Journal for Research in Mathematics Education*, 19 (1), pp.44-63.

Gravemeijer, K., 1994. *Developing realistic mathematics education,* Utrecht: Frudential Institute.

Gravemeijer & Cobb, P., 2006. Design research for alearning design perspective. In J.V.D Akker, K.P.E. Gravemeijer, S. McKenney, N. Nieven (Eds.), *Educational Design Research* (pp.17-51). London: Routledge.

Gravemeijer & Van Eerde, D., 2009. Design reasearch as the mean for building a knowledge base for teaching in mathematics education. *The Elementary School Journal*, 109(5).

Huerta, M. P., 2011. Assesing difficulties of conditional probability problems. In T. R. Marta Pytlak (Ed.), *Cerme 7 Proceedings of the Seventh Congress of the European Society for Research in Mathematics Education,* (pp. 807-817). Poland: University of Rzeszow.

Lalos, P. Lazarinis, F and Kanellopoulos, D., 2008. *e-SNAKES and LADDERS: A hypermedia educational environment for portable devices*, Greece: University of Patras.

Melrose, J., 2007. *A probability game*, England: Loughborough.

Purnanindya, R., 2012. *Pengembangan game edukasi ular tangga sebagai media pembelajaran TIK untuk siswa kelas 3 SD Negeri Pujokusuman 2,* Yogyakarta: Universitas Negeri Yogyakarta.

Putri, R., 2010. *Pengaruh pendekatan pembelajaran dan bentuk tes formatif terhadap hasil belajar matematika dengan mengontrol intelegensi siswa SD di Palembang.* Jakarta: Tesis Universitas Negeri Jakarta.

Putri, R., 2011. *Improving mathematics comunication ability of students in grade 2 through PMRS approach.* Palembang: Universitas Sriwijaya. Online: http://eprints.uny.ac.id/1371/1/P%20-%2054.pdf. Accessed 16 Desember 2014.

Putri, R., 2012. *Pendisainan Hypotetical Learning Trajectory (HLT) Cerita Malin Kundang Pada Pembalajaran Matematika.* Seminar Nasional Matematika dan Pendidikan Matematika FMIPA UNY, 10 November 2012. Yogyakarta.

Putri, Ratu & Zulkardi. (2013). *Eksplorasi nilai-nilai kearifan lokal melalui desain pembelajaran inovatif matematika Pendidikan Matematika Realistik Indonesia (PMRI).* Palembang: Universitas Sriwijaya.

Putri, R. & Zulkardi, 2007. An innovation for developing a qua;ity of mathematics education in Indonesia. *Proceeding Earcome 4*, 16-20 Juni 2007. Penang Malaysia.

Sina, I., 2011. Implementasi model pembelajaran role playing berbasis analisis SWOT pada Materi peluang. *E-Jurnal Cakrawala, 6* (10).

Sharma, S., 2006. Personal experiences and beliefs in probabilistic reasoning: implication for research. *International Electronic Journal of Mathematics Education*, 1(1).

Taylor, Felicia. M., 2010. Why teach probability in the elementary classroom?. *International Journal in Mathematics Education*.

Yumarlin, 2013. *Pengembangan permainan ular tangga untuk kuis mata pelajaran sains Sekolah Dasar.* Yogyakarta: Universitas Janabadra.

Zulkardi, 2002. *Developing a learning environment on realistic mathematics education for indonesia students teachers.* Doktoral Dissertation. Enschede: University of Twente.

Zulkardi, 2005. *Pendidikan Matematika di Indonesia: Beberapa permasalahan dan upaya penyelesaiannya.* Palembang: Universitas Sriwijaya.

Zulkardi & Putri, R., 2010. *Pengembangan blog support untuk membantu siswa dan guru matematika indonesia belajar Pendidikan Matematika Realistik Indonesia (PMRI).* Diakses tanggal 14 Desember 2014. http://eprints.unsri.ac.id/540/1/Prof.DrZulkardi_Dr.Ratuilma_di_JIPP-Balitbang.pdf.