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THE LEARNING TRAJECTORY OF NUMBER PATTERN LEARNING USING *BARATHAYUDHA* WAR STORIES AND UNO STACKO

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Abstract

In recent years, several researchers have tried to use stories and games as a starting point for learning mathematics. This is allegedly able to increase students' mathematical abilities and make learning mathematics more enjoyable. Therefore, this research is aimed to design a mathematics learning trajectory in pattern number using *Barathayudha* War Stories and Uno Stacko games as a starting point or context in the learning process with the Indonesian Realistic Mathematics Education (IRME) approach. The research method used is a design research that contains three stages, preliminary design, teaching experiment, and retrospective analysis. The result of this research is the learning trajectory design of number pattern learning using *Barathayudha* war stories and Uno Stacko. The design consists of four activities, which is a detective of *Barathayudha* war; rebuilt *Abimayu* fortress at the battlefield of *Kurusetra*; find the unique secret number code of *Abimayu* fortress; and built another fort using number pattern. The results showed *Barathayudha* war stories and Uno Stacko can stimulate students to understand their knowledge of pattern number concept which is the stages in the learning trajectory of student have an essential role in understanding the concept.

Keywords: Learning Trajectory, Number Pattern, *Barathayudha* War Stories, Uno Stacko, Design Research

Abstrak

Dalam beberapa tahun terakhir, sejumlah peneliti mencoba untuk menggunakan cerita dan permainan sebagai titik awal pembelajaran matematika. Hal ini disinyalir dapat menumbuhkan kemampuan matematis siswa dan membuat pembelajaran matematika menjadi lebih menyenangkan. Oleh karena itu, penelitian ini bertujuan untuk mendesain lintasan belajar matematika pada materi pola bilangan menggunakan cerita peperangan *Barathayudha* dan permainan Uno Stacko sebagai titik awal atau konteks dalam proses pembelajaran menggunakan pendekatan Pendidikan Matematika Realistik Indonesia (PMRI). Metode yang digunakan dalam penelitian ini adalah penelitian desain yang terdiri dari 3 tahapan, yaitu desain pendahuluan, percobaan pengajaran, dan analisis retrospektif. Hasil dari penelitian ini merupakan desain lintasan belajar pada pembelajaran pola bilangan menggunakan cerita peperangan *Barathayudha* dan permainan Uno Stacko. Desain ini terdiri dari 4 aktivitas, yaitu seorang detektif dari perang *Barathayudha*, membangun kembali benteng *Abimayu* di medan perang Kurusetra; menemukan kode nomor rahasia unik dari benteng *Abimayu*; membangun benteng lain menggunakan pola angka. Hasil penelitian menunjukkan bahwa kisah peperangan *Barathayudha* dan Uno Stacko dapat merangsang siswa untuk menumbuhkan pemahaman siswa tentang konsep pola bilangan, yang mana seluruh tahapan dalam lintasan belajar yang dilalui siswa memiliki peran penting dalam penanaman konsep tersebut.

Kata kunci: lintasan belajar, pola bilangan, Cerita Peperangan *Barathayudha*, Uno Stacko, Penelitian Desain

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The development and application of the mathematics concept daily problems are part of a learning process (Tanujaya, Prahmana, & Mumu, 2017). Freudhental (1991) explained that mathematics is a human activity and must be related to daily life. However, in reality, the mathematics in schools tend to be taught using practical formulas and most often, not seamlessly associated with everyday life and culture, as should be experienced by the students (Stacey, 2011; Arisetyawan, Suryadi, Herman, & Rahmat, 2014; Nurhasanah, Kusumah, & Sabandar, 2017). The society, including the teachers, generally does not regard mathematics to be related to culture, and the learning of mathematics in the

classroom can also be regarded with almost having no relation to culture. In fact, culture is part of a student's life that may guide the way a student learns and regard mathematics (Stacey, 2011; Revina, 2018; Revina & Leung, 2019). It may significantly influence the student's ability to solve mathematics projects that relate to daily life. The results of the Programme for International Student Assessment (PISA) for Indonesia showed that the students' abilities to solve and interpret problems in various situations are still considered at a level, which is low (Kamaliyah, Zulkardi, & Darmawijoyo, 2013).

Subsequently, Irawan and Kencanawaty (2017) and Sembiring, Hoogland, and Dolk (2010) suggested that appropriate strategies and learning methods are needed to develop students' thinking ability that orientate towards technical skills and the reformation of mathematics education based on problem-solving in the daily life. The learning method suggested is the *Pendidikan Matematika Realistik Indonesia* (PMRI), which is an adaptation of the Realistic Mathematics Education (RME). The PMRI is aligned with the Indonesian culture, geography and the ability of Indonesian society in general (Soedjadi, 2007; Sembiring, Hadi, & Dolk, 2008; Prahmana, Zulkardi, & Hartono, 2012, Arsaythamby & Zubainur, 2014).

Furthermore, Wahyudi, Zulkardi, and Darmawijoyo (2016) and Subijanto (2015) explained that one of the contexts that can be used in PMRI is a culture that is applied to realistic mathematics learning and modified according to the local context where the school is located. Consequently, it may result in engaging, contextual knowledge if it is to be taught in schools as it may increase the students' ability to solve a problem that has a relation to their daily life. Also, the cultural context can be a solution to the lost aesthetic value and character of a student due to the influence of modernization (Prahmana, 2017; Grigoryan, Lebedeva, & Breugelmans, 2018; Uge, Neolaka, & Yasin, 2019). Other researchers also use cultural contexts such as folklore as a starting point for learning mathematics, including the use of *Legend Putri Dayang Merindu* story as folklore in understanding Least Common Multiple (Triyani, Putri, & Darmawijoyo, 2012) and the legend of *Kemaro* Island story for supporting students in learning average (Lestariningsih, Putri, & Darmawijoyo, 2012). These results show that the cultural context can support students to develop their mathematics knowledge.

On the other hands, professional teachers, as the product of reform in education, must have higher education qualifications and be able to innovate in teaching and learning (Prahmana, Zulkardi, & Hartono, 2012; Risdiyanti & Prahmana, 2018). So, every prospective teacher should be prepared to become a professional teacher to equip himself through higher education and knowledge of the learning and teaching process.

In Yogyakarta, there is a study club called the Yogyakarta Mathematics Study Club (YMSC) consisting of several mathematics education graduates who are engaged in innovating mathematics learning as a way to improve the qualifications and innovative learning abilities for graduates of mathematics education in Yogyakarta. In this research, some of YMSC members act as research subjects (students) who are given treatment in the form of mathematics learning activities using cultural context and games, namely *Barathayudha* war stories and Uno Stacko game.

The culture context product should be fun and contained concepts of mathematics for learning purposes and aspects of moral values (Radovic, Black, Williams, & Salas, 2018; Risdiyanti, Prahmana, & Shahrill, 2019). The design learning activities of the number pattern using *Barathayudha* war stories and Uno Stacko game are expected to be innovative in terms of learning mathematics so that the concept will be easy for students to understand thus enabling them to solve any daily-related problems. This context was chosen mainly because of its familiarity with the participants from the perspectives of culture as well as their daily life. Furthermore, this design is expected to cultivate and develop the cultural values that may influence a student's character.

METHOD

This research uses design research as a research method. Design research was chosen in this research because this method is a systematic and flexible method to improve the quality of learning in the classroom by collaborating between researchers and teachers to develop a learning design (Gravemeijer, 1994). The development of learning design is carried out in three phases, which are preliminary design, design experiment, and analysis retrospective (Bakker, 2004; Gravemeijer & Cobb, 2006; Simonson, 2006; Prahmana, 2017).

The preliminary design aims to design the Hypothetical Learning Trajectory (HLT), which is then refined in the design experiment stage (Prahmana, 2017). The activities carried out in this stage are collaborating with the teacher to conduct a literature review of the concept of number patterns, realistic mathematics education, and contexts that can be used in learning number patterns namely *Barathayudha* war stories and Uno Stacko game. Also, researchers analyzed the concept of number patterns in the mathematics education curriculum in Indonesia. Furthermore, the results of the literature study and curriculum analysis were used as a basis for designing learning trajectories and developing conjectures to become HLT. In this case, theory aims as guidelines that will improve in each learning activity, so it is flexible and can be revised during the experimental design stage.

In the design experiment stage, the learning trajectory that has been designed at the preliminary design stage is then implemented in the learning process (Prahmana, 2017). The purpose of this implementation is to explore and observe the strategies and thoughts of students. There are two cycles in this stage; the first cycle is a pilot experiment that aims to evaluate and improve the learning trajectory that has been designed. The second cycle is a teaching experiment that seeks to implement a learning trajectory that is evaluated and revised in the pilot experiment of the design experiment stage. The implementation of number pattern learning activity using *Barathayudha* war stories and Uno Stacko game consists of four activities.

The last stage is retrospective analysis. All data collected in the design experiment stage are analyzed by comparing conjecture and HLT with the results of the application of the learning trajectory that has been carried out in the design experiment stage (Gravemeijer & Cobb, 2006). From the results of the analysis will obtain a learning trajectory description of number pattern learning using

Barathayudha war stories and Uno Stacko game.

RESULTS AND DISCUSSION

The results of this study obtained a trajectory description of the number pattern learning using the *Barathayudha* war story and Uno Stacko. The learning activities consist of four activities. The first activity is to be a detective of *Barathayudha* war. Activity two is to rebuild *Abimayu* Fortress at Battlefield of *Kurusetra*. Furthermore, the third activity is to find the unique secret number code of *Abimayu* fortress. Lastly, the fourth activity is to build another fortress using the number pattern. Students can understand the concept of number patterns using the *Barathayudha* war story and Uno Stacko. It viewed from the results of the final evaluation and the positive responses of students.

Regarding this learning can be seen from the comments, students feel more comfortable understanding the number pattern using this context. The results of this study indicated that the learning design of number patterns using *Barathayudha* War Story and Uno Stacko has very important to be the starting point and can increase student motivation in the learning process. In detail, the researchers discusses the results of this study as follows.

Activity 1: Be a detective of Barathayudha War

The learning activities begin with the teacher describing the *Barathayudha* war, which is a civil war between *Kurawa* and *Pandhawa* in *Pewayangan* Stories. The student will be told the original story, for, in the end, it will be slightly modified to fit the material to be learned. *Barathayudha*'s story was chosen as the starting point because this learning was carried out in Java, which was very thick with the *Pewayangan* stories culture. So, it would create a new stigma for students who had felt that actually, mathematics was far from their lives to think that mathematics existed and became part of their culture.

In this activity, it told that at once upon a time. There was a civil war between *Kurawa* and *Pandhawa*. In the *Pewayangan* story, *Kurawa* and *Pandhawa* have the same father named *Prabu Pandhu,* but from different mother. Before dying, *Prabu Pandhu* handed over the authority of the state to purify *Pandhawa,* because he was considered capable of managing and leading wisely. *Kurawa* did not accept his father's decision and always tried to seize the power of *Pandhawa* (Susetya, 2007). Finally, one day, a civil war took place on a battlefield, namely *Kurusetra*. The Hindus believe that *Kurusetra* existed on this earth precisely in India, but no one had succeeded in proving the truth.

At the time of the war, *Abimayu,* one of the members of *Pandhawa* made a triangular fortress of rock arranged in a unique arrangement of numbers, consisting of the results of repetitive number operations. According to archeologists, there are several ways to prove whether the war really happened and took place in *Kurusetra,* India are by breaking the secret code used *Abimayu* to compile the fort (Susetya, 2007; Suparjo, 2011; Priyatni, 2016). Based on historical records, it is known that the fortress was composed of 30 pieces of stone, consisting of 8 levels, the most basic of which had eight bricks,

and the top is one brick (Hatley, 2005; Susetya, 2007). Until now, no one has been able to crack the secret code.

After the story is complete, the teacher provokes the students' interest in breaking the secret code. The teacher invites students to be a detective looking for truth. They seem to be in *Kurusetra*, India and found the ruins of the fort there, but did not know whether the debris was a fortress built by *Abimayu* as in the *Pewayangan* story. Therefore, students formed a group of 4 to 5 people who acted as a detective team. The team did research by collecting debris that was suspected of being *Abimayu*'s fortress and then rebuilt and solved its secret code. In this study, the fortress debris is illustrated using Uno Stacko sticks. As a result, at this stage, the students were enthusiastic about listening to the *Pewayangan* story and were interested in deciphering the secret code of *Abimayu* fortress which was actually a pattern number.

Activity 2: Rebuilt Abimayu fortress at battlefield of Kurusetra

In this activity students who have collected fortress debris that is suspected to be the fortress of *Abimayu*, then they try to compile the fort with the arrangement as recorded in history that the *Abimayu* fortress is triangular in shape, arranged uniquely, consisting of the results of repetitive number operations, organized of 30 pieces of stone that from 8 levels, the bottom is composed of 8 pieces of stone. The top is arranged for one stone. At this stage, students need creativity and critical thinking because students must expect a form of the fort that they have never seen, and they rebuild that fort only based on the clues given. As a result, students managed to make a fortress with an arrangement that formed a triangle with eight levels and the provision of each level, creating a number pattern. The students' activities of rebuilt the *Abimayu*'s fortress can be seen in Figure 1.

Figure 1. Students rebuilt *Abimayu* fortrees at battlefield *Kurusetra*

Activity 3: Find the unique secret number code of Abimayu fortress

In the third activity, students are given a student worksheet, which will serve to help students find the secret code of the *Abimayu* fortress arrangement. The student worksheet consists of columns that will be filled with the number of stones arranged in each level. Then students look for the relationship

of the number operation of the number of rocks arranged on each level. It is done to test whether the structure that students make has been the same as the one recorded in history, and to prove the truth of the ruins of the fortress in *Kurusetra*, India is the landscape of *Abimayu* in the puppet story. At this stage, students then look for formulas from the number pattern that has been found. The activity in the third stage is essential to do as a bridge to understanding the concept of number patterns from the formal level to the informal level.

Figure 2. Students find the unique secret number code of *Abimayu* fortress

Activity 4: Built another fortress using number pattern

In this fourth activity, students make a fortress with a pattern according to the number pattern they want as this stage, students' understanding has been on understanding the informal level. Students have understood the concept of number patterns and can make these patterns without using the help of Uno Stacko sticks and can visualize the number pattern in the form of a fort made using Uno stick.

Figure 3. Students built another fortress using number pattern

All activities could change the stigma of students and society that mathematics that is felt far from daily life exists and becomes part of the culture of the community. This study was able to take on the role of developing the learning trajectory of number pattern learning using *Barathayudha* war stories and Uno Staco as the local context of education. In addition, a few of researchers have documented the results of their research related to the implementation of daily activities of students in the learning process of mathematics, such as using *Tepuk Bergambar* Indonesian traditional game in learning number operations (Prahmana, Zulkardi, & Hartono, 2012), playing one house in learning number operations (Nasrullah & Zulkardi, 2011), *Patok Lele* stakes in learning measurements (Wijaya, 2008), *Kubuk Manuk* Indonesian traditional game as stimulated starting point to understand the knowledge of the social arithmetic concept (Risdayanti, Prahmana, & Shahrill, 2019), and *Gasing* game in measuring time learning (Jaelani, Putri, & Hartono, 2013), and several mathematical activities in estimating, measuring, and making patterns using Sundanese culture (Muhtadi, Sukirwan, Warsito, & Prahmana, 2017). Therefore this study takes a role to add to the study of contexts that can be used as a starting point for learning mathematics.

CONCLUSION

The learning trajectory can be practiced using local contexts such as culture or other things easily found in the daily activities of the students. The students were able to understand the concept of number pattern more easily since it is fun for them and importantly after doing all learning activities. Lastly, the game is also relatable to activities in their daily life.

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