

Students' Strategies of Measuring Time Using Traditional *Gasing* Game in Third Grade of Primary School

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Abstract

Understanding of measuring time has difficulty for children because it is intangible. Standar units often use directly by teacher for learning time measurement. Many researches involved game in designing learning material to facilitate fun and meaningful learning for children. For this reason, learning of time measurement that connect with children's daily experience was designed. The context of this research was traditional *gasing* game. The study is situated in implementation of Indonesian version of Realistic Mathematics Education, labeled as PMRI. This research aimed acquire learning trajectory of time measurement using traditional *gasing* game for the third grader of primary school by describing students' progress in learning. Design research methodology comprising preparing for the experiment, teaching experiment, and retrospective analysis was used. The research was conducted in SD (Sekolah Dasar) Pusri (Pupuk Sriwijaya) Palembang as one of PMRI (Pendidikan Matematika Realistik Indonesia) school. The result of the teaching experiment showed that learning design could foster students to experience reinvention of time measurement historically. It stimulated students to emerge their sense of time, measure time using non standar unit, understand the concept of standard unit, and measure time using standar unit. Students' strategies that were emerged showed students' progress through situation and problems that were provided by traditional *gasing* game.

Keyword: time measurement, *gasing*, design research, PMRI

Abstrak

Siswa mengalami kesulitan ketika belajar mengukur waktu karena waktu merupakan nilai yang tidak dapat diindera oleh manusia. Satuan standar sering digunakan secara langsung oleh guru dalam mempelajari pengukuran waktu. Permainan telah banyak diikutsertakan dalam suatu pendesainan pembelajaran untuk mendukung siswa mengalami pembelajaran yang bermakna dan menyenangkan. Hal ini dijadikan dasar untuk mendesain sebuah pembelajaran yang dikaitkan dengan sesuatu yang dekat dengan siswa dalam kehidupannya. Permainan *gasing* tradisional dijadikan sebagai konteks untuk desain pembelajaran dalam penelitian ini. Pembelajaran menggunakan model PMRI, yang merupakan versi Indonesia dari RME. Tujuan dari penelitian ini adalah menghasilkan lintasan pembelajaran pengukuran waktu yang menggunakan permainan *gasing* tradisional di kelas III Sekolah Dasar yang dijelaskan melalui proses perkembangan pemikiran siswa. Penelitian ini menggunakan metode design research yang terdiri dari tahap-tahap preparing for the experiment, teaching experiment, dan

analisis retrospektif. Penelitian dilakukan di SD Pusri Palembang sebagai salah satu mitra sekolah PMRI. Hasil dari teaching experiment menunjukkan bahwa desain pembelajaran ini dapat membantu perkembangan siswa untuk mengalami pengukuran waktu secara historis dan menstimulasi siswa untuk memunculkan sense of time, mengukur waktu menggunakan satuan tidak standar, memahami konsep kekonstanan dalam satuan standar, dan mengukur waktu menggunakan satuan standar. Strategi-strategi yang muncul dari siswa menunjukkan perkembangan pemahaman siswa melalui situasi dan permasalahan yang terdapat dalam permainan gasing tradisional.

Kata kunci: pengukuran waktu, gasing, design research, *PMRI*

Introduction

Measuring time is a human activity that has started since human civilization itself there. Before 1600, Galileo has made measurements using his pulse (Glennie & Thrift, 2009). Calendar system that is universally known and used at this time was derived from the development of the Roman calendar which existed at the time of Julius Caesar in 46 BC (Holdford-Strevens, 2005).

Learning time measurement and emerging sense of it are important for primary school students so that students do not make mistakes early when they perform calculation of the results of time measurement. NCTM (National Council of Teachers of Mathematics) states that measurement is one of the most fundamental of all mathematical processes (Dacey et al, 2005), including the measurement of time. Reys Suydam, and Lindquist (2003) state that measurement as a mathematical topics studied by primary school students are most often used in everyday life. Many students have difficulties in measuring time because it is intangible (Buys & Bakhove, 2005)

Freudenthal (1991) states that mathematics must be connected with reality. Norvell (2007) argues that students can learn the concept of time using the game that includes the concept of duration. The research of Wijaya (2008) showed that *gundu* and *benthik*, as one of Indonesian traditional game, can be used as starting point when students learn to measure length between two objects.

In this research, researcher involved traditional *gasing* game as the context for learning time measurement. Traditional *gasing* game has the situation that provides the need of students in measuring time.

Theoretical Framework

Time Measurement

Buys & Bakhove (2005) state that the time express cyclical character. It can be shown from a variety of time instruments within a certain time interval. These drive people for identifying time easily.

Time can be taught of as the duration of an event from its beginning to its end. Students can understand about the measurement of time through the concept of duration (Norvell, 2007). They should make comparisons of events that have different duration. In order to think of time as something that can be measured, it is helpful to compare two events that do not start at the same time (Walle, 2007).

The measurement time can be started from the measurement time by using nonstandard units of time. Walle (2007) exemplifies one of the activities to measure time using nonstandard units of time which measures the time an event of short duration using pendulum swing. Actually, students often experiences measurement activity but they are not aware and perform to discuss it formally. Learning design can facilitate students to perform measuring using non standar unit intuitively.

According to Brumbaugh (2004), to measuring time using standar unit, the analog clock is more representative than digital clock. The use of it is a meaningful activity. It will help to understand the concept of duration of time associated with the units.

Reys, Suydam, and Lindquist (2003) give outline of steps for learning time measurement generally. It is described in the following table. below.

Table 1
The outline for learning time measurement

Activity	Sub Activity
Identifying the attribute by comparing objects	<input type="checkbox"/> Perceptually
	<input type="checkbox"/> Directly
	<input type="checkbox"/> Indirectly
Choose a unit	<input type="checkbox"/> Arbitrary
	<input type="checkbox"/> Standard
Comparing the subject to the unit	<input type="checkbox"/> Arbitrary
	<input type="checkbox"/> Standard
Finding the number of units	<input type="checkbox"/> Counting

Using Instruments

Using formulas

PMRI (Pendidikan Matematika Realistik Indonesia)

PMRI is the Indonesian version of RME developed by the Freudental Institute in Netherlands (Sembiring, 2007). RME is an approach in teaching and learning mathematics (Zulkardi, 2001). Heuvel-Panhuizen (1996) states that Freudental, one who first proposed the idea of RME, argues that mathematics must be connected to reality, close to the students, and relevant. RME theory was being developed in the United States, namely MiC (Mathematics in Context) (Romberg, 2001) and in South Africa namely RaMESA (Realistic Mathematics Education in South Africa). Besides, the theory of RME is in line with the trend of development of mathematics curriculum materials in other countries, including Portugal, Britain, Spain, Brazil, Denmark, Japan, and Malaysia (de Lange, 1996 in Hadi, 2005).

Hadi, Zulkardi dan Hoogland (2010) mentions five tenets for Realistic Mathematics E below.

1. *Use of contexts for phenomenologist exploration*

The instructional activities start from situation that is experientially real for students.

2. *Use of models for mathematical concept construction*

It use models and symbols as a bridge from situational problem to formal knowledge.

3. *Use of students' creations and contributions*

Students are free to construct and describe their ideas and strategies in solving the problem.

4. *Students activity and interactivity in the learning process*

Learning process of students is not a solo activity but it occurs in a social situation..

5. *Intertwining mathematics concepts, aspects, and units*

Intertwinment is an integration a variety of mathematics topic in instructional activity.

Traditional Gasing Game

Gasing is a toys that can stand and spin on its axis in balance (Delta Pamungkas, 2004). Traditional *gasing* can be made from wood or bamboo that is carved and shaped as the body of it. Objects used as the spinner is a rope that made from nylon, yarn, or bark.

Traditional *Gasing* Game had been known people in Riau since the Dutch colonial era in Indonesia. At that time, this game very quickly spread to many regions in Indonesia. It creates a variety of *gasings* that embeded their physics characteristic, such as *gasing* from Bangka Belitung, Bali, Jakarta, West Java, and Lombok.

The traditional *gasing* game can be used as a context in learning time measurement for students because the winner criteria of this game is player that can play his or her *gasing* to spin in the longest time. Learning about the measurement of time using traditional *gasing* game will be something that is interesting and fun.

Methodological Research

Design Research

In design research, the aim is to formulate HLT (Hypothetical Learning Trajectory) which can be elaborated and refined during the research process (Gravemeijer & Cobb, 2006). Consequently, methodology used in this research is design research that consists of several phases, namely preparing for the experiment, teaching experiment, and retrospective analysis. Experience-based activities were design to support understanding and thinking for students in third grade of primary school. In HLT, learning time measurement using *gasing* contains the goal, description of activities, and conjecture of students' strategies and thinking.

Data Collection

The data of this research are written and audio-video data

Subject

The teaching experiment was conducted in class IIIB, SD (Sekolah Dasar) Pusri (Pupuk Sriwijaya) Palembang as one of PMRI (Pendidikan Matematika Realistik Indonesia) school.

Result and Analysis

In the teaching experiment, the use of traditional gasing game brought students to the context of understanding the concept of measuring time. These activities used traditional gasing game was measuring time informally as the experience for students to measuring time formally. Students was capable to develop their strategies to solve the problems of playing gasing and time measurement.

1. Comparing two spinning gasing directly to determine the winner of playing gasing together

Traditional *gasing* game that was played together by Arkan and Ehsan showed that it was able to emerge sense of time of students. Students decided that Arkan was the winner by looking at Arkan's *gasing* was still being spun when *gasing* was played by Ihsan had stopped spinning (Figure 1).

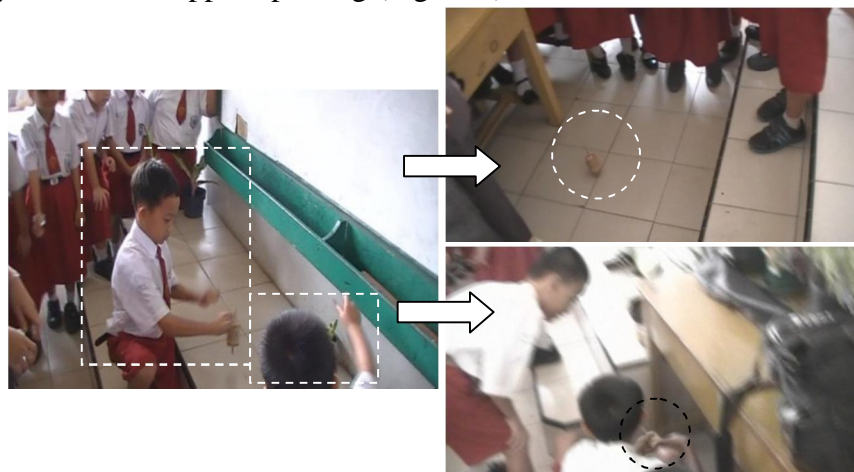


Figure 1. Students compare gasings that was played directly

Ihsan's gasing slid into under the table and hit the legs of it after playing. Aslam was taking Ihsan's gasing because it had stopped spinning.

Aslam : It has stopped spinning, Mom. It has stopped spinning, Mom. (showing Ihsan's gasing held to the teacher). It is already stopped before,

Teacher : Whose is it?

Students : Ihsan.

Aslam : It means the winner is Arkan.

This game had been bringing students to directly compare the time directly. The winner was the player who his or her *gasing* could spin the longest. The criteria of this winners emerged in discussions held after the match.

Teacher : Why did we determine that Arkan was the winner?

Ben : Because Arkan's gasing spun longer than Ihsans gasing.

Teacher : How was gasing game that was played could take place fairly?
Rafi : It was given a cue.

Students knew that the players must be played their gasing together in order to run the match fairly. One of strategi was to give a cue to the players before starting to play it. If the players did not played together, students had difficulties to determine the winner.

By doing a traditional *gasing* game played together, the learning was able to raise the sense of time of the students. It prepared students to measure time. In addition, one of the concept of the same time in measuring time had been introduced.

2. Counting orally to yield non standar unit of time measurement

Gasing matches played by turn had prompted students to find the idea of unit of time. The absence of other gasing spin at the same time, because there was one gasing played only, forced students to look for another comparison that could be used to determine its winner. Banjarmasin group done counting orally to determine the winner when they playing gasing match in turn (Figure 2).

Dialog of this activity between teacher and students about how students exploit their strategy after they perform counting orally to their friends in the second leg of gasing match played by Arkan and Ihsan describes below.

Teacher : How do you know that the spin Ihsan's gasing is longer time?
Nadia : Calculating its spin.
Teacher : How many count do you get?
Nadia : 35.
Teache : Whose is it?
Nadia : (Pointed to Ihsan).
Teacher : How is Arkan Gasing? (pointing to Arkan).
Nadia : 8.
Teacher : So, who is the winner?
Nadia : Ihsan



Figure 2. Banjarmasin group counting orally

Counting orally to measure time that had been done by students could not be used as a appropriate tool to determine the winner of the match of gasing game. It was fully realized by the students. They indicated disagreement about fairness to determine the winner using counting orally in gasing match when the teacher raised the conflict in time measurement using it.

Teacher play two gasing by turn. When the first gasing was spun, she measured its spin using oral counting fast (one, two, three, ..., and so on) and when the second gasing was spun, she measure the time of its spin using oral counting slowly (one ... two ... three ..., ..., and so on)

Teacher : Who is the winner, the first or the second?
Student : The first
.Teacher : Why?
Student : Because it has longer time.
Nadia : 62.
Teacher : Is it fair?
Students : No.
Teacher : How should you do in order to get fair counting?
Adam : we must use same counting.
Teacher : What is the same?
Rafi : It should be played in the same time.
Rio : Same in counting.
Teacher : How do you count?
Irfan : It must be same in the speed of counting.
Teacher : Is there any instrument that has same speed to measure time fairly?
Rio : Yes, there is It is clock.
Tegar : Stopwatch.

Students could directly mention the standard instrument that could be used to measure the time fairly because students was very familiar with the clock that was faced on their daily activities. This activity obtained students' knowledge about the constancy of the time unit and learning experience more meaningful than just a direct measure using standar instrument already available.

3. Counting orally in conjunction with the movement of clock hand

Learning activities of students who had previously performed again as an impact when students measured the time of gasing spin using a clock (Figure 3). Student measured the duration of gasing spin by counting orally in conjunction with the movement of the second hand on the clock (Figure 4).



Figure 3. Students measured the spin of gasing using the clock

At the beginning of measuring time using the clock, oral counting of some students was more quickly than the movement of the second hand of clock. When the teacher reminded to measure the spin of gasing while looking at the clock, students consciously adjusted their counting and the movement of the second hand of clock. This agreed with concept of the same time obtained students in the previous gasing match.

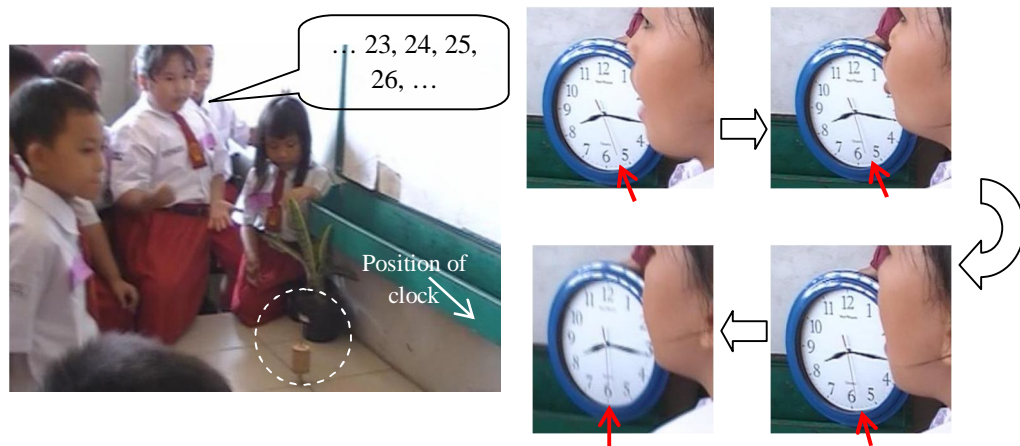


Figure 4. Students counted orally in conjunction with the movement of clock hand

4. Counting the strip and the space of the strip of second interval on the clock

The result of the duration of an event is determined by the starting and end point. In the next activity, students determine the duration of an event provided by describing it to know strategies of formal knowledge emerged by students.

There were two strategies performed by students to determine duration of an event (Figure 5), that are counting the strip and counting the space of the strip of second interval on the clock.

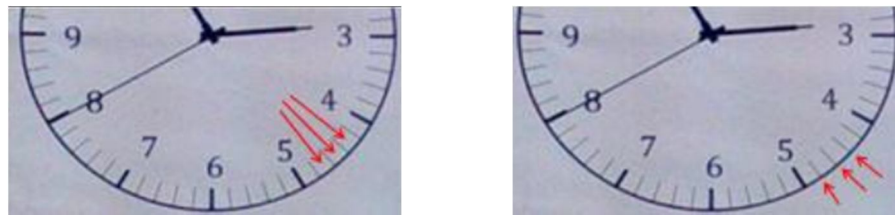


Figure 5. Students' strategies to determine the duration of an event

The first was done by Athiya, Rani Reyhan and Adam and the second strategy was done by Rafi and Raissa. There are two same strategy done by Athiya (Figure 6) and Rani but they got the different results (Figure 7).

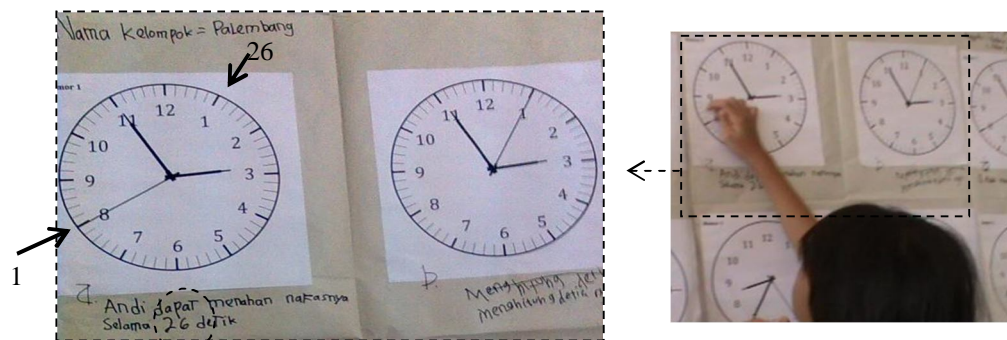


Figure 6. Athiya's strategy

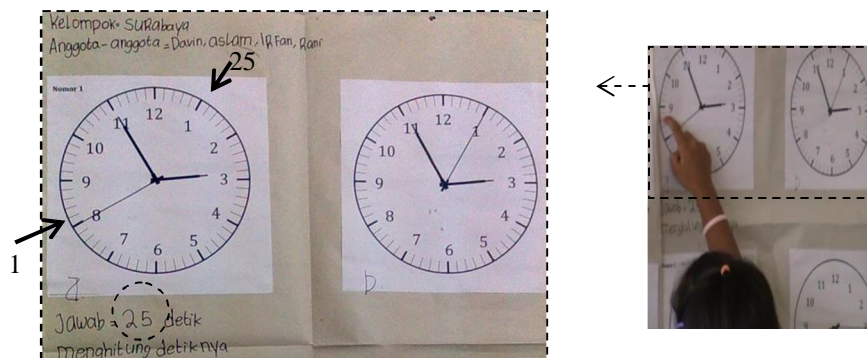


Figure 7. Rani's strategy

Athiya's strategy did not included the concept of duration in measuring time. She did not referred to a counting based on the movement of the clock hand. Compared with Athiya's strategy, Rani understood the concept of measuring time better. Rani used previous experience that an interval marked by two strips only passed by the clock hand in a one time. Rani referred to the movement of the clock when she measured time of *gasing* spin.

Conclusion

Learning design could that involves traditional *gasing* game foster students to experience reinvention of time measurement historically. It stimulated students to emerge their sense of time, measure time using non standar unit, understand the concept of standard unit, and measure time using standar unit. Students' strategies that were emerged showed students' progress through situation and problems that were provided by traditional *gasing* game.

Gasing is the context that is suitable for preliminary teaching and learning the concept of time measurement. Learning trajectory resulted for supporting emergence of students' strategies as a model consists of playing traditional *gasing* game together, playing traditional *gasing* game in turns, measuring time using clock, determining the duration of an event.

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