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Designing Reflection and Symmetry Learning by Using Math Traditional Dance in Primary School

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Abstract

The innovation of education is an important point of Pendidikan Matematika Realistik Indonesia (PMRI), one of them through traditional dance as a context of national cultural. Dance that collaborated with concept of mathematics, it is called Math Traditional Dance. This research aims to produce learning line (specific) the material of reflection and symmetry. The research method used is design research that consisted of preparing for the experiments, teaching experiments, and retrospective analysis. Data collected through observation, interviews, documentation and field notes. This research was conducted with 22 students in MIN 2 Palembang. From the try out that is obtained from the formal to the informal learning described in the learning process, so that support learning process of mirroring and symmetry for the students in grade four in elementary school.

Key words: PMRI, math traditional dance, design research, learning path, mirroring and symmetry

Abstrak

Inovasi dalam pendidikan adalah salah satu poin penting pada pendekatan Pendidikan Matematika Realistik Indonesia (PMRI) yang salah satunya melalui tarian tradisional sebagai konteks budaya nasional. Tarian yang dikolaborasikan dengan matematika diistilahkan dengan Math Traditional Dance. Tujuan penelitian adalah menghasilkan lintasan belajar pada konsep pencerminan dan simetri dengan menggunakan Math Traditional Dance berdasarkan PMRI di kelas IV SD/MI serta meyelidiki peran lintasan belajar terhadap pemahaman konsep bagi siswa kelas IV MIN 2 Palembang. Metode penelitian yang digunakan adalah design research yang terdiri dari tiga tahap yaitu, preparing for the experiment, teaching experiment, dan retrospective analysis. Pengumpulan data dilakukan melalui observasi, wawancara, dokumentasi dan catatan lapangan. Ujicoba penelitian dilaksanakan di MIN 2 Palembang di kelas IV A yang melibatkan 22 siswa. Dari ujicoba dihasilkan lintasan belajar yang valid dari formal ke informal yang dideskripsikan pada aktivitas pembelajaran, sehingga lintasan belajar ini mendukung proses pembelajaran dan pemahaman berpikir geometris siswa kelas IV pada materi pencerminan dan simetri sehingga lintasan belajar ini berperan sistematis dan kondusif bagi siswa kelas IV MIN 2 Palembang.

Kata kunci: PMRI, *math traditional dance, design research,* lintasan belajar, pencerminan dan simetri

Introduction

Creating an atmosphere of learning mathematics in the classroom to be fully inspirative, creative, and innovative for the learners is one of the duties and responsibilities of teachers. One of the innovative learnings that utilizes local-cultural context is combining culture (arts) and mathematics. "*Culture and Arts can help practitioners train and develop a further understanding of Dance Mathematics principals*," (Kokona: 2009, p.3). At first glance, it might seem that mathematics, realm of rationality, and dance that is in the form of art of physical and emotional expression has little in common.

There are a lot of significant mathematical ideas that can be found in dance such as symmetry, time and space, combinatorics, rotation, number, geometry, patterns, and also for learning in higher education, such as Graph. This opinion is supported by McCutchen (2006, p.315): "*Math is a good partner for dance because of the geometric shapes in space, patterns, symmetry and asymmetry, and counting of phrases. However, geometric shapes are mathematical constructs that can be difficult to translate into artful movement. Oftentimes they are too stiff and contrived. Geometrics can be more useful the concepts are more organic and less contrived*." Learning mathematics using dance is known as Math Dance. It is interesting because using dance means students do learning activities by moving their limbs. It is parallel with Fruedhethal (1991, p.16-17) who emphasized the idea of mathematics that must be connected to reality through problems. The term "reality" in this context does not mean that the problem that always encounter in daily life. The term "reality" means that the problem will occur based on students' real experience.

Math Dance is an exploration that will be liked by students because it is combined by the rhythm in language, math in art, and a good source to examine the ideas of the dance movements. This idea is supported by Mulyardi (http://www.p4mriunp.wordpress.com) that: "*Semua permainan, tarian, alat musik, randai, pitatah dan petitih Minangkabau bisa dijadikan sumber dan inovasi dalam belajar matematika, contohnya Tari Indang. Melalui pemanfaatan budaya bangsa berarti kita tetap menjaga kelestarian budaya sehingga pembelajaran matematika lebih bermakna dan menyenangkan bagi siswa.* "

Although Indang dance originated from West Sumatra, but the dance is very famous and its movements are not difficult, then this dance is usually danced by students in

South Sumatra. Hilda, she is an art teacher in MIN 2 Palembang telling us that: "Learners are taught with arts and culture through dance, painting, folk music. Through cultural arts classes' nation is expected to remain sustainably."

To combine math concepts with dance which was followed by students to get some experiences, a physical sensation that always makes an abstract concept in mathematics must be the activity that was more meaningful for students. According to the opinion of Schaffer: *Mathematical problem-solving is incorporated when creating new dances, which can even inspire new mathematics. Concepts can be taught in the ballroom and applied in the classroom, bring together movement, rhythm, geometry, and more*. Math Dance in classroom will be more delightful because the students feel more fun. Wistrom (2009, p.2) said: "*Try using math and science teaching methods. Teaching strategies that are both unexpected and fun are, after all, often the most memorable*." In Math Dance, students are expected to have creative thinking in order to train the process of critical thinking and logical learners.

Literature Review

This chapter provides the theorical framework that is addressed to construct grounded of this research. Literature about symmetry was studied to identify the basic concepts that are required to do a correct result to count fold symmetry. Futhermore, this literature was useful in designing instructional activities in which each of the basic concepts of symmetry are taught in the proper level of young children and also how mirror be connected to daily life reasoning.

In this research, Indonesian traditional dances were exploited as experience-based activities and contextual situation to build upon students' reasoning and reach the mathematical goals of symmetry.

a. Symmetry

Symmetry is a fundamental part of geometry, nature, and shapes. It creates patterns that help us organize our world conceptually. We see it every day but often don't realize it. *The implementation of symmetry not only we found in geometry but also in architecture, design of graphics, arts, music, dance, etc* (Adams, 2005, p.18). If a spatial operation can be applied to a shape that leaves the shape unchanged, then the object has symmetry. There are three fundamental symmetries: translational symmetry, rotational symmetry, and reflection symmetry.

Symmetry is also a part of geometry's lesson in the school that is learned when students study in kindergarten, like fold of origami's paper. This topic is found in fourth and fifth graders in primary school. In primary school, this topic just introduces folding symmetry and rotated symmetry. In the fourth grade, students only learn folding symmetry. Students from each early grade got some experiences of symmetry because it is an aspect of our bodies and nature. Owen (2003) said that: "*Student may move away from the initial symmetry but still all the shapes and balance their art works*." In everyday, we found the symmetry concepts likes butterfly, plane, building, etc.

b. Indang Dance's

Indonesia rate consists of several customs and traditions. Its diverse culture can be found in Indonesia. Indang's dance reflects Islam arrival in West Sumatra. It is also called "tarian badindin," from the lyrics "dindin ba dindin" the song accompanying this dance. The lyrics also tell about the Allah the Almighty, everything is done aimed to rend God Blessy.

Current Indang art nowadays has changed and movement along with the development of cultural-social of the society from time to time. Art is a product of society culture which is never escape from society; with several cultural activities including: creating, giving opportunity to glide, maintaining, spreading, and developing again. Those of things are satisfied by Indang art video which is applied, some motions of Indang dance have been modernised without losing important aspects.

The art of Indang has three dimension of art which are literatures, music, and dance. *The formal of presentation are three groups to make triangle in rows position* (Ediwar, 1999, p.18). The formal presentation of Indang's dance is compensation. The text consists of art of Indang from distich and line up. So, to mach it with math, we can see the move of dance.

In history, the art of Indang's dance consist of the growth and development of Moslem religion in West Sumatra. The first, its show uses the medium to teach the Islam from Ulama and religion's teacher in mosque, so that, the opinion of society about Indang dance is art of mosque.

Indang is one of several art forms with an Islamic flavour to be found in West Sumatra. This torically speaking, its presence is a realization of the Islamic

education system of the prayer house or *surau,* in stride with the Islamic missionary activities and process of Islamization taking place in this area. It subsequently developed into a folk art from which was performed in a place known as laga-laga.

During the last few years, Indang has developed into an art form which is market oriented. Its players have begun to package its form of performance, text and music in accordance with the current taste of the masses. In addition, nowadays Indang is also starting to be used as a tourist commodity, particulary in the West Sumatra areas.

c. Math Dance

Combining math and dance concepts allows people to experience a physical sensation of abstract concepts of math. Mathematical problem solving is incorporated when creating new dances, which can inspire new mathematics. The concepts of math dance can be taught in the ballroom and applied in the classroom, brought together such as movement, rhythim, geometry and more.

Wistrom (2009, p.2) said that: "*Try using these math and science teaching methods. Strategies such as these will help your students learn science and math. Teaching strategies that are both unexpected and fun are, after all, often the most memorable*." It sometimes so happens that a physics teacher is expected to work with no material resource. This is a situation in which simple and decent body movements can some to the teachers rescue as science and math teaching strategies. We usually associate such activities by teaching language and social studies only. "*Math is a good parther for dance because of the geometric shape in space, patterns, symmetry and asymmetry, and counting of phrases*, (McCuthchen, 2006, p.315)." However, geometric shapes are mathematical construction that can be difficult to translate into artful movement.

All dances can be sources of learning using the Math Dance, but the dance should be adjusted with mathematical concepts to be developed. In class, learning Math Dance is creating a full atmosphere of inspiration, creativity, and enthusiasm for students, because it uses a context that has been experienced by learners.

d. Realistics Mathematics Education in Indonesia (PMRI)

A decade of PMRI in Indonesia tells a story mathematics reform project in Indonesia. PMRI is adopted from RME, this method from Dutch. Over the last ten

years, the PMRI teams, with the support of a group of Ducth mathematics educators, created a new image of mathematics education in primary or middle school. The PMRI movement is on the brink of scaling up to a condesiderably larger number of schools. There is an urgentneed to putin place some tools that will communicate the basic ideas of PMRI development and pilots, vast body knowledge has been acquired on PMRI education in Indonesia. This body of knowledge has been discussed on many occasions. According to Fruedenthal by Ariyadi, mathematics should be connected to reality through problem situations. The terrm "reality" means that the problem situation must be experientially real for students.

1. Three Principles of PMRI:

a) Guided reinvention and didactical phenomenology

The theory of mathematics in PMRI is a human activity, so guided reinvention can be described that teacher should give students a chance to understand and do mathematics process by them when mathematics was found. This principal can be inspired by using procedure informally. This effort will be reached if teaching and learning processes use real context in daily life which are related to mathematics concept. This research will use traditional's dance, in general, we can know that dancing is a habit for students who are starting from kindergarten. So this context is something that has been experienced by students.

b) Progressive mathematization

The situation that contained with phenomenon that can be used for material and application area in teaching and learning mathematics should be started from real situation before getting to the top (formal mathematics). Two kinds of mathematization should be used as references in teaching and learning mathematics from concrete to abstract (formal).

c) Self-developed models

The role of self-developed models is as a bridge for students from concrete to abstract or informal to formal. It means that students can make their own model to solve problem. The problem is started with the situation that closed to the students' daily life. From generalization and formalization, the model will be changed into *model-of*. Then, *model-of* will be shifted to *model-for* in

the same problems. In this section, the students will be assisted by using nail planes, terraced sheets, handkerchiefs, and origami's paper.

For the next question of how to proceed from situational activities to formal mathematics, the tenets of Pendidikan Matematika Realistik Indonesia (PMRI) offer clues and design hueristics.

2. Five tenets of PMRI

The process of designing a sequence of instructional activities that starts with experience-based activities in this research was inspired by five tenets for realistic mathematics education defined by Treffers (1987) that are described in the following ways:

a. Phenomenological exploration

As the first instructional activity, a concrete context is used as the base of mathematical activity. The mathematical activity is not started from a formal level but from situation that is experientially real for students. Consequently, this research employed Indonesian traditional dances as the contextual situation.

b. Using Model and symbols for progressive mathematization

The second tenet of RME is bridging from a concrete level to a more formal level by using models and symbols. Students' informal knowledge as the result of experience-based activities needs to be developed into formal knowledge of symmetry. Consequently, the " making math dance" activity in this research was drawn on to bridge from symmetry activities in the games as the concrete level to using a ruler in symmetry as the formal level of symmetry.

c. Using students' own construction

The freedom for students to use their own strategies could direct to the emergence of various solutions that can be used to develop the next learning process. The students' strategies in each activitywere discussed in the following class discussion to support students' acquisition of the basic concepts of symmetry. The students – made symmetry instrument served as the bases of the emergence of dance as the preliminary of a normal moving.

d. Interactivity

The learning process of students is not merely an individual process, but it is also a social process. The learning process of students can be shortened when students commmunicate their works and throughts in the social interaction emerging in the classroom. Dancing forms a natural situation for social interaction such as students' agreement in deciding a strategy for the fairness of their dances

e. Intertwinement

Intertwinement suggests integrating various mathematics topics in one activity. The Indonesian traditional dances used in this research did not merely support learning for symmetry, moreover they also supported the development of students' symmetry.

Methodology

Design research methodology, comprising design, teaching experiment, and retrospective analysis phase (Cobb et al., 2001; Gravemeijer, 2004), was employed as a research method in this study. Gravemeijer & van Eerde (2009) illustrate the reflexive relation between thought experiment and instructional or teaching experiment in design research as can be seen in Figure1.

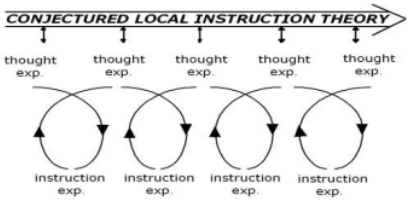

Figure 1. Reflexive relation theory and experiments

In this paper, we will go through the design research mini-cycles of meeting 2 briefly to justify our design in meeting 2, which contain the main discussion on the symmetry. During the preparation for the experiment, the researcher made the preliminary design, suchas studying literature and designing the hypothetical learning trajectory (HLT). In this phase, a sequence of intructional activities containing conjectures of students' thinking was developed. The conjectured hypothetical

learning trajectory was dynamic and could be adjusted to students' actual learning during the teaching experiments. In teaching experiment phase wew conducted in two lessons in which the duration was 70 minutes for each lesson. Before doing a teaching experiment, teacher and researcher discussed the upcoming activity. Finally, the retrospective analysis phase, HLT was used in the retrospective analysis as guidelines and points of references in answering research questions.

Result and Discussion

Students first learned the concept of reflection. They worked in groups to find the "mirror" of reflection, which is the axis of symmetry. The teacher them prepared a video "dancing symmetry." This is an art-infused lesson about symmetry that links dance and math. When dancers move symmetrically, students were asked to think of a line of symmetry as a vertical line from top to bottom dividing dancers' bodies into right and left parts.

At the beginning, teacher gave apperception like the following

Teacher: "Why should you fold your clothes at home?"
Student : "So, they become neat."
Teacher: "How do you that neatly."
Intan : "Every corner of the clothes should coincide, Miss."
Teacher: "Good."

Later students realized that the folding line would be the axis of symmetry of clothes. Following this, students watched "badindin dance" video and worked on student's worksheet together in small groups. This worksheet contains problems to determine the axis of symmetry. In Figure 2, for example, students were asked to find any axis of symmetry.

Figure. 2. Axis of symmetry

There are three strategies: estimating, folding the figure, and trying to measure the figure. Students watched the video of “kupu-kupu” dance and decided where the axis of symmetry locates.

In second activity, students folded handkerchiefs distributed to each group. At the beginning, students folded the square handkerchiefs into four parts, but after the teacher gave a clue on how to fold the handkerchiefs into the former shape, they understood and found 4 ways of folding. A group was then asked to present their strategy of folding in front of class.

In the third activity, the students folded the origami paper of various shapes to find axis of symmetry. It took quite a long time before the students realized that the axis of symmetry is just a line that divides the shape into two identical parts. The teacher encouraged in groups to find such lines as many as possible through group discussion. Each group was then asked to present their results on folding symmetry in class discussion. Some students, however, still had difficulty in determining number of folding symmetries of pentagon.

An interesting discussion occurred when the students were discussing the number of folding symmetries of circles. They came up with many different answers as predicted. Here is a snapshot of the discussion.

Teacher : "Now we will discuss the number of folding symmetries of circles. *Durian* group, can you how many folding symmetries of circles?"
Student 1 : "Two, Miss ...."
Teacher : "Well, do you have different answers?"
Student 2 : "Twenty-nine, Miss ..."
Teacher : "Fine... What about your result *Buah Naga* group? "(writing the student’s answer on the whiteboard).
Student 3 : "Four, Miss."
Teacher : "Okay ... What about your result *Mangga* group?"
Student 4 : "Two also, Miss."
Teacher : "*Jambu Air* group."
Student 5 : "Six, Miss..."
Teacher : "Waaach, there are so many different answers, let's try again!"
Student 6 : "Fifteen, Miss ..."
Teacher : "Let's try again, it can be different again!"

The teacher wrote other students’ answers like 35, 50, and 100. Pasha spontaneously said: “a lot, Miss,” followed by others saying, “countless.” The teacher directly justified this answer and explained that in mathematics "countless" is known as

"infinite." The discussion was concluded with a table of different geometric shapes and their corresponding number of folding symmetries.

At the beginning, students folded the square handkerchiefs into four parts, after the teacher warned (how to fold the handkerchiefs into the former shape), and then the students understood and found 4 kinds of folding. In order to make students understood the symmetry concept; the teacher asked one of the groups to present their strategy in front of the class.

Then the third activity, the students folded the origami paper in various forms of flat shape that had been prepared. In this step, the students got their ideas in a long time, because some students still did not know the names of flat shape, the process in this step was so long, after doing their group, teacher guided students by observer of each group. There were some groups, who still had one way to fold it, then students were reminded again by teacher, how to fold the paper property.

Some pictures in the process:

Figure 3: Folding the square

Figure 4: Result of students

Figure 5: Strategies the students

Figure 6: Folding the flat shape

Figure 7. Students' explanations

Figure 8. Folding the circle

In the paper folding activity, there were who made wrong answers, so the concepts of symmetry can be understood by students, teacher invited students to discuss in their group, and this discussion was guided by the teacher. Students wrote their answers on white board and then some groups were asked to be the next to present how many fold symmetry that each student obtained on flat shape, here we can see students were active, because it looked almost all students wanted to work, then the teacher wrote the correct answers from the students, students were not able to distinguish between

rombus and parallelogram. To determine the number of fold symmetry, students didn't find the significant difficulty. However students difficulty found when they determined the number of fold symmetry on pentagram, have many students were wrong.

Early activity introducing symmetry concept by showing both palm, later,then the teacher submits to students that if only we do not have palm which is symmetry, what a difficult life for us. Here the teacher have developes attitude of thankfullness to God, self esteem which is given by God little by little will be planted in student.

Figure 9: Discussion of students

Collaborative working is a strategy associated with RME theory. Learning activities should engage an interactive principle. Within group discussions, interactivity among students, as well as interactivity between students and teacher, leads to a different kind of communication. Two-way communication between students and the teacher needs to be built up. The students said that collaborative work and discussion was interesting because it improves their ability to argue about mathematics and to share their mathematical ideas in the discussion forum. Collaborative work also teaches students the spirit of *gotong royong*.

Figure 10: The activity of students

The students feel that this approach is relaxed and less formal. They can share their mathematical ideas. The smarter students can share their experiences to the group work discussion. In teaching activity, the teacher always starts the class with challenging problems which is n context or based on students' experience. This builds downright behavior to student. Class discussions entangle some opinions from the students. This builds attitude of appreciating each other's opinion.

Figure 11: Presentation of student in front of class

The result shows that using traditional dance in mathematics classrooms can improve students' understanding on the concept of symmetry.

Concluding Remarks

Used PMRI approach, teachers though students by linking learning with the reality of students experience and suitable with situational. Through traditional dances, students are expected to associate the concept of symmetry. In this design, the materials regulated that the students guided re-invention the concept of symmetry. This process learning showed that in mathematics, the focus is not on mathematics as a ready-made product but the activities, the process of horizontal and vertical matematisasi required the initiative and creative of students to make the active of students. Horizontal mathematizing in symmetry learning process is characterized by traditional dances and math dance, then the vertical matematizing studied by *model of* and *model for*

such as folding a handkerchief, then the students folded the origami paper with the forms of flat shape and the last is equipped with formal matters.

The teacher and the teacher educators to facilitate students with worksheets, in our study, the students were found two strategies that students obtained in determining the axis of symmetry, there is a folded three directly, but there is also the first measure the distance between the dancers, then known at the material circle of students have many ways in determining the amount of folding of the plane symmetry of the circle, but eventually students are able to answer many of the later described by the teacher that is very much was known by the term "infinite."

Through these activities, students are trained in critical thinking and argumentative, it's very useful for students to develop their insight and knowledge. It is expected that through learning to use the math dance through traditional dances at the Indonesian context, to make students more interested and excited in learning math.

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