DESIGN RESEARCH IN MATHEMATICS EDUCATION: MAP READING SUPPORTS THE DEVELOPMENT OF SPATIAL ABILITY

A THESIS

Submitted in Partial Fulfilment of the Requirements for the Degree of Master of Science (M.Sc) in International Master Program on Mathematics Education (IMPoME)

International Master Program on Mathematics Education (IMPoME Graduate School Sriwijaya University (In Collaboration between Sriwijaya University and Utrecht University)

By:

Elika Kurniadi NIM. 20112812002





FACULTY OF TEACHER TRAINING AND EDUCATION

SRIWIJAYA UNIVERSITY

JUNE 2013

CHAPTER I

INTRODUCTION

Most people frequently face spatial problems in their daily life. Spatial forms can be represented in pictures or diagrams which are useful for communicating ideas. A picture is a kind of representation of spatial ideas such as a geometrical drawing, maps, plans, etc. Young children have many spatial experiences with their environment, especially through the sense of sight and touch (Dickson, 1984). The spatial experience starts before the development of language. Spatial matters are involved in learning and teaching mathematics as a representation of the real world. Lowrie (2010) suggested that students need spatial ability that allows them to consider all the elements of a task, including specific features of a graph and the surrounding text, when solving a mathematical task.

Clarke (2003) stated that maps are the main source of spatial information and spatial ability which is required to decode maps because of the spatial relation among visual elements. Many tools and instructional devices can help children to develop and organize their own thinking in map understanding. A map is such a kind of representation in graphic form. Therefore, a map can be a bridge between the real world and abstract world. In addition, it might help children to understand the other graphs in mathematics and science. Liben (2008) asserted that students in elementary school have a basic understanding of maps.

Developing map understanding is important to increase the spatial ability in reading maps because there is a positive relation between map understanding and spatial ability. For instance, persons with better spatial visualization can interpret map content properly. Moreover, persons with better spatial orientation are able to compare map content to the surrounding environment (Rusch, 2008). However, according to the result of Diezman & Lowrie's study (2007) reported that 10-13 year old children have difficulty to understand the information in maps. Therefore, it is necessary to bring the students in the class into the map reading activities

Likewise, many educators do not give attention to map understanding and sometimes high jump to an abstract level in mapmaking and map reading. Drawing is a process that allows children to figure out the representation emotionally in their thinking (Sobel, 1998). Children can start the reading and writing process by telling stories, drawing a picture of the story, and writing the story in their own words. It is important for children to draw in the beginning of the process of mapmaking.

In recent years, many studies were conducted that consider the spatial ability and map literacy. Realistic Mathematics Education in geometry makes extensive use of interesting spatial and map tasks (Gravemeijer, 1990), but unfortunately, research on the effects of this specific strand is lacking. Moreover, there is a few of research for this domain in Indonesia (Mariana, 2010; Revina, et.al.2011). Realizing the importance of spatial ability and map literacy, we will design a learning sequence by using maps as a tool to support the development of spatial ability. Therefore, the purpose of this study is to contribute the local instruction theory of spatial ability particularly map reading. Consequently, the study is guided by the research question: *How can map activities support the development of spatial ability particularly map reading?*

CHAPTER II

BACKGROUND AND RESEARCH QUESTION

2.1 Spatial Ability

A Spatial ability is an ability that consist of declarative and perceptual forms of knowledge to transform, manipulate, combine and operate information presented in a visual, diagrammatic or symbolic form (Lohman, et al, 1987; Hegarty & Kozhevnikov, 1999). Spatial ability can be used in particular representation and reasoning include diagrams, drawings, maps, and models. The three important elements of spatial ability are concept of space, tools of representation, and process of reasoning (National Research Council, 2006, p.12-13).

Table 2.1

A general description of spatial ability

Aspect	of	snatial	Abstract concept
ability	01	spatial	riostract concept
Space			The relationship among units of manyuramont (ag
space			- The relationship allong units of measurement (e.g.,
			kilometers versus miles)
			- Different ways of calculating distance (e.g., miles and time)
			- The basis of coordinate systems (e.g., Cartesian versus polar
			coordinate)
			- The nature of spaces (e.g., 2-dimensional versus 3-
			dimensional)
Representation		n	- The relationships among views (e.g., orthogonal versus
-			perspective maps)
			- The effect of projections (e.g., area map projections)
			- The principles of graphic design (e.g., organization in reading
			graph or map)
Reasoni	ng		- The different ways of thinking about shortest distance (e.g.,
			route distance in a rectangular street grid)
			- The ability to extrapolate and interpolate (e.g., estimating the
			slope of a hillside from a map)
			- Making decisions (e.g. selecting an alternative route)

Grattoni (2007) found that students' practice spatial abilities would improve their math ability. Although, that study was in small participant, the finding is similar to another study (Hegarty & Kozhevnikov, 1999) that showed spatial representation could promote problem solving success. It seems that spatial skills play an important role in solving certain kinds of mathematical problem solving. For example, the problem from calculus and geometry often explore the relation between time and area.

Lowrie (2010) suggest that students need to get spatial ability that allow them to consider all the elements of a task, including specific features of a graphic and the surrounding text, when solving mathematical task. Elementary students' spatial thinking improves more over the school year (Newcombe, 2010). A recent meta-analysis showed substantial improvements in spatial skill from wide variety of interventions, including academic coursework, task-specific practice, and playing computer games that need spatial thinking. Clarke (2003) stated that maps are the main source of spatial information and spatial ability is required to decode maps because of the spatial relation among visual elements. Therefore, the present study has intention to develop children's spatial ability through learning by using a map.

2.2 The Development of Spatial Ability

Piaget and Inhelder (1967) defined three stages in the development of spatial ability: (1) Preoperational stage is started from egocentric children to locate objects in their environment with respect to themselves. Children in this stage

understand limited topological spatial relationships. (2) Concrete operational stage occurs between seven to nine years old. They develop a cognitive map with a fixed frame that allows them to imagine and orient their body. Children also develop more complex understanding about external frame of topological relation such as left/right. (3) Formal operational stage is begun around 11 years old. Children develop an understanding of Euclidian spatial relation such as estimating distance.

Particularly, the present study is related to the map understanding which is closely to the spatial orientation. Therefore, we also focus on the developmental progression in spatial orientation (Clements & Sarama, 2009):

Table 2.2

The developmental progression in spatial orientation

Age (years)	Developmental progression		
0-2	Understands initial vocabulary of spatial relations and location.		
2 – 3	Orient a horizontal or vertical line in space		
4	Extrapolate lines from positions on both axes and determine where		
	they intersect if meaningful context		
5 - 6	Can extrapolate two coordinates, understanding the integration of them		
	to one position, as well as use coordinate labels in simple situations.		
7	Reads and plots coordinate on maps		
8+	Can follow and create maps, even if spatial relations are transformed.		

The participant of the research is that second graders in primary school. It means that we focus on the concrete operational stage in spatial ability. In designing activity in the classroom, we consider the developmental progression at 7 to 8 years old.

The better approach for mapping experience is in visual, kinesthetic, and emotional. However, many educators do not attention with those and sometimes do high jump to abstract level in mapmaking and map reading. Children start the reading and writing process by telling stories, drawing a picture of story, and writing the story in their own words. It is important for children to draw in the beginning process in mapmaking. Drawing is a process that allows children to figure out the representation emotionally in their thinking. Children's map represents their experience of beauty, secrecy, adventure and comfort. The development of emotional bonds and cognitive skill needs to go hand in appropriate approach. The progression of children's mapmaking is microcosm of cognitive development in elementary school (Sobel, 1998). Considering the development cognitive of children in every level age and phase thinking, it addresses about the phase of children thinking for each two level age, from five until twelve ages. Each phase of thinking is related to some appropriate context of map for each level age children. For instance, five and six year old children are familiar with context related to their home and neighborhood. Asking first graders about a neighborhood map can make sense for them.

2.3 Map Understanding

In general, maps are visual representation/graphic data where information is encoded through the spatial location of fixed position marks (Mackinlay, 1999). It is necessary to deal with understanding the map. Wiegand (2006) stated five types of fundamental knowledge to well understand a map:

- a) Understanding that map represent space
- b) Understanding the alignment and perspective of the map
- c) Understanding scale
- d) Understanding symbols and texts
- e) Using maps to find the way

The representation of mathematical ideas, concepts, and relationship in graphical form is common in mathematics. Graphic include graph, maps, diagrams, hierarchies and network. Liben (2008) stated that students in elementary have basic understanding about map. Developing this understanding is notable to increase the ability in reading maps properly because according to the result of Diezman&Lowrie's study (2007) is that 10-13 year old has difficulty with the information in maps to understand it. In the last five years, Diezman and Lowrie have explored how students interpret the mathematical graphic including maps with their own structure and spatial arrangement.

The model of map understanding is in line with how our brain arranges knowledge and spatial process. Many tools and instructional devices can help children to develop and organize their own thinking in map understanding. Map is such a kind of representation in graphic form. Therefore, a map can be a bridge between the real world and abstract world and help children to prepare understanding the other graphs in mathematics and science. Based on cognitive perspective, an increased emphasis on map understanding will enhance the objective of greater mathematical and scientific literacy.

2.4 Spatial skills and maps for children

In the classroom, teaching and learning are limited and fail to connect map skills with other curriculum areas, including mathematics. Most students do not have ability and understanding to use map even. Moreover, many of young children get difficulty and misunderstanding about space that is conflict between sensory concrete and abstract frames of reference. Therefore, Clement (2009) suggested that it is important to guide children to:

- a. Develop abilities to build relationship among objects in space.
- b. Extend the size of that space
- c. Link primary and secondary meaning and uses of spatial information
- d. Develop mental rotation abilities
- e. Go beyond map skills to engage in actual use of maps in local environment
- f. Develop an understanding of the mathematics of maps.

Children need to learn about model and maps including incidental and planned experience such as frequent discussion about spatial relation, finding a missing object, and finding the way back home. Teacher should provide instruction on using maps that explicitly relates to world space and maps. It might be started by generating four mathematical question (Clements & Sarama, 2009): (1) Which way (direction), (2) How far (distance), (3) Where (location), (4) What objects (identification). Children must learn about mapping process and more sophisticated ideas of direction and location. In addition, they should develop navigation ideas, such as left, right, front, back, etc. Then, they might represent these ideas in simple route maps within the classroom.

Therefore, a specific experience with map can help students to get more understanding about map. For instance, the present study will encourage children to work with model animals to build maps of the zoo with these models. Children might use cut out shapes of animals, trees, and sandbox in the playground and lay them out on a felt board as a simple map. These are good starting situation. Models and maps should eventually move beyond simple iconic picture and challenge children to connect the abstract and sensory-concrete meanings of maps symbols. Introducing such situation can evoke geometric correspondences. Realistic Mathematics Education in geometry makes extensive use of interesting spatial and map tasks (Gravemeijer, 1990), but unfortunately, research on the effects of this specific strand is lacking.

2.5 Realistic Mathematic Education (RME)

RME is the domain specific instruction theory that offers a framework for interpreting students' activity in learning mathematics (Gravemeijer, 1994). According Freudenthal's view, two important points in learning mathematics are that mathematics must be "real" and mathematics as a human activity. In teaching

mathematics realistic, the teachers should consider to the mathematizing which is a process to interpret, organize, and construct meaning of situation with mathematical modeling. The mathematizing involves the spatial relationship (Gravemeijer, 1994). The present study considers the spatial aspect in mathematics through a learning map. We design Hypothetical Learning Trajectory (HLT) for supporting students' development of map understanding particularly spatial ability aspect. The design influenced by five characteristic of RME (Treffers, 1987, cited in Zulkardi, 2002) as described follow:

a. Use of contextual problem

The real and meaningful context is important thing for students as a starting point for learning process. In this design, the context of map provides students to develop their spatial ability. The problem about map allows students to realize what are they doing and generate some questions, wonder, and critical thinking, such as why and what if.

b. Use of Model

This design used a map as a representation of model between the real worlds to the abstract world. Map is kind of geometric model in mathematics.

c. Use of students' contribution

The series of instructional activity consider the opportunity to students in contributing their own informal problem solving strategies. The activity of map reading offers the students to use their previous experience about map. d. Interactivity

Students' interaction enhances justification agreement and reflection on the work (Gravemeijer, 1994). During the learning process, students will be encouraged in classroom discussion, such as gallery poster session will prompt students to discuss the map that their produce in mapmaking activity as a part of the design.

e. Intertwining of learning strands

Map skills as the topic of the design is related to the spatial aspects in mathematics closely to build geometric building visualization. In addition, this topic also intertwine with geography lesson particularly map reading. It shows that the connection to other subjects is more meaningful in real world.

2.5 Map reading in Indonesian curriculum

The topic of map activity in Indonesian curriculum is firstly introduced as a part of social subject for elementary students. The table below describes topic of map for grade 1 in Indonesia curriculum (Depdiknas, 2006).

Table 2.3

Map topic in Indonesia curriculum

The second Semester of Grade 1						
Standard Competence	Basic Competence					
2. Describe the neighborhood	2.1 Tell the important experience around					
	the neighbourhood.					

It is not common in Indonesia to learn about map activity as a part of teaching and learning mathematics in the school. It shows less emphasis to consider the map understanding as a part of spatial ability aspect in mathematics classroom. Therefore, the present study would like to focus on the process of how students understand the maps to support the development of spatial ability in mathematics classroom.

2.6 Present study

In the previous study of Shintia's thesis, it considers about spatial ability especially spatial visualization. That study provided some activities that are in line Pendidikan Matematika Realistik Indonesia (PMRI). The study found that spatial visualization task can support students spatial structuring in learning volume measurement. The present study is also related to the spatial ability, we provide the activity of map which is following the characteristic of PMRI. The activity of map is such learning process by using maps to support the development of spatial ability. The hypothesis of this study is that the activities of map can help children to develop their spatial ability. Related to the hypothesis, the researcher formulated research question for this study: *How can map activities support the development of spatial ability particularly map reading?*

The research question is focused on the role of the map activities in supporting children's learning. The study investigated the influence of the instructional sequence of map activity on the development of students' spatial ability. The components of the instructional setting can contribute to supportive map activity. The analysis is emphasized to a better understanding of the complexity of such an instructional setting and its influence on the development of students' spatial ability.

CHAPTER III

METHODOLOGY

3.1 Research approach

The purpose of the present study is to contribute the local instruction theory of spatial ability particularly map reading. The study focuses on the general research question: How can map activities support the development of spatial ability? The activity of map is such learning process by using maps to support the development of spatial ability. This implies that the researchers need to design an instructional sequence of map activity and research how the design supports students to reach particular end goals. Therefore, the approach of present study used design research because it considers design as a crucial part of the research. The main reason of use design research is to develop Hypothetical Learning Trajectory (HLT) together with instructional material and to contribute the local domain theory of Realistic Mathematic Education (RME) especially in spatial aspects. The main result of design research is not a design that works, but the reason why, how, and to what extent it works. Therefore, a design research is evaluated as an innovation and improvisation that are useful in educational practice because it is grounding in experience and developing in practice to generate empirically grounded theory.

3.2 Data collection

3.2.1 Preparation phase

In this phase, the researcher collected some various data to get some information as a starting point of the research. The data of preparation phase is described as following:

a. Classroom observation

The researcher observed the class experiment before doing the teaching experiment. The purpose of classroom observation is to know :(a) the culture of classroom, (b) teacher's and students' activity, and (c) the interaction between teacher and students during teaching and learning process. The researcher took video recording and field notes during classroom observation. The classroom observation will be guided by the list topic in scheme of observation (appendix 1).

b. Interview with the teacher

Interview with the teacher was conducted after the classroom observation. The aim of interview is to know the teaching and learning process from the teacher's perspective and to clarify the data of classroom observation. The interview will be guided by the list topic in scheme of interview (appendix 2). Furthermore, the interview was recorded in audio recording and be backed up by making field notes.

3.2.2 Preliminary teaching experiment (first cycle)

The first cycle of design was conducted in small group consist of 5 students grade 2 in Indonesia elementary school. The researcher was a teacher in this cycle. The

teaching and learning process was recorded in the video recording. In addition, the researcher collected the written work of student and conduct mini interview to know the response of students' thinking about the content of the design. Therefore, the purpose of the first cycle is as a pilot study to test the conjectures and improve the design and also as a discussion with the teacher who will implement the design in the second cycle.

3.2.3 Teaching experiment (second cycle)

The second cycle of the design was held in one class of grade 2 in Indonesia elementary school. The teacher implemented the revision of design according the result in the first cycle (appendix 3). In this phase, the researcher has two focus group consists of 2 students who are in the middle level of achievement. During the teaching and learning process, the researcher collected the data of video recording by using one static camera that focus on the work of focus group and one dynamic camera that record classroom activities. Some interesting fragments of video were chosen to be transcribed and analysed in retrospective analysis. The researcher also took field notes for teaching and learning process. In addition, the written works of students were collected to know students' thinking during the teaching and learning process. Field notes and copies of students' written work are additional data sources.

3.2.4 Pre-test and Post-test

- Pre-test

To assess the pre-knowledge of the students' thinking and achievement about the topic, the pre-test was held before teaching experiment. The participant of pre-test is all of student in the teaching experiment class and students worked individually. In the pre-test, there are some problems related to map understanding and spatial ability as a topic of the research.

- Post-test

Similarly, the post-test was given to students of teaching experiment class to know the students' achievement after teaching experiment phase. Students solved some problems about map understanding and spatial ability.

3.2.5 Validity and reliability

The validity and the reliability from the result of the research can be considered as the quality of the research. In this research, the validity and reliability were regarded from the two ways which are internal and external:

a. Internal validity is mostly related to the quality of data collection. In this issue, the present study considers about the various data such as interview, observation, and video recording which lead to the data triangulation. The validity of finding can be checked by using different source of information. For instance, considering the type of data, the researcher makes efforts to corroborate the interview data with the other sources of information, such as observation and field notes that can provide some back-up for the content.

- b. External validity refers to generalizability of the result from the specific contexts to other contexts. An important way to do so is by framing issues in more general.
- c. Internal reliability refers to the reliability within a research. We consider the data from video recording to improve the internal reliability. The selective fragment of video recording will account to the reasonableness and argumentative power of inferences and assertions.
- d. External reliability refers to the track ability. The research must be clear in such a way the reader can track the learning process and reconstruct the study.

3.3 Data analysis

3.3.1 Preparation phase

a. Classroom observation and interview with teacher

The selected fragment of the data classroom observation and teacher interview was transcribed and analyzed. Observation and interview criteria are analyzed to find out the description about classroom culture between students' and teacher's interaction each other's. These observation criteria are defined in terms of both verbal and nonverbal behaviors. Therefore, the result of those analyses will be used to get the insight into the context which lesson will be conducted. **b.** Pre-test

In analyzing the result of pre-test, the focus is on the strategy that students use to solve the problem about map in the written test. The analysis will be done in quantitative and qualitative analysis. The students' solution to each of the problem were investigated and identified as a particular level of students' spatial ability. The results of pre-test takes account into a starting point of students' thinking in HLT and contribute to insight of a developmental trajectory for students' spatial ability.

3.3.2 Preliminary teaching experiment (first cycle)

During preliminary teaching experiment in small group, the selected fragment from video recording and interview with students was transcribed and analyzed to consider the content of HLT. The reflection after the preliminary teaching experiment led to adapting the conjectures and the teaching sequence, which became the starting point for a teaching experiment in the second cycle. This cyclic process aimed both at empirically grounded answers to hypothesis concerning the research question and at a conjectures local instruction theory. Changes in HLT are purposed to create optimal condition in the second cycle. In addition, the pre-test and post-test that is given in the first cycle were analyzed to know students' thinking and achievement in quantitative and qualitative analysis. Therefore, the results of first cycle were used to revise the HLT since it shapes the idea about activities, the level of students and the possibilities of the education setting in HLT.

3.3.3 Teaching experiment (second cycle)

The data collection during the teaching experiments varied. The researcher collected students' work, field notes, and video recording of every lesson. The researcher analyzed the data of pre-test and post-test in the second cycle. Moreover, some interesting students' work was selected to figure out how students solve the problem and to be used for testing the conjectures in HLT. The field notes are written up into lesson reports which identify the important episodes from classroom discussion to the particular students in the learning process of all lessons. In addition, the researcher watched the video registrations of each lesson and transcribed the transcript of the interesting fragment video. It is used to describe the group discussion or the classroom discussion and to analyze the students' contribution. The results of the analysis were regarded to draw the conclusions, to answer the research question and to revise the HLT.

3.3.4 Post-test

The researcher need to analyze the result of pre-test to investigate what extent students had reached the learning goal after the teaching experiment. The result of post-test was analyzed in quantitative and qualitative analysis. The researcher will compare the result between the post-test and pre-test.

3.3.5 Validity and reliability

During retrospective analysis phase, the researcher discussed with supervisors. The discussion can support the validity and reliability of the data analysis.

- a. Internal validity: the different source of data which is data triangulation was used in data analysis. During the analysis, the researcher tested conjectures that are generated at specific episode from different data material such as fields' notes, tests, and students' works.
- External validity concerns to the results of HLT on generalizability of the conclusion presented in such a way that other researcher can adjust them to their own local settings.
- c. Internal reliability refers to the discussion with others to interpret the data and draw the conclusions.
- d. External reliability emphasis on the track ability. The teaching experiments and data analysis were guided by the conjectures of HLT. The researcher describe this process systematically in such a way it offered other researchers the possibility to replicate the learning process and draw the same conclusion through the cycles of teaching experiments and data analysis.

Chapter IV

Hypothetical Learning Trajectory

A HLT is a framework of learning activity that consists of learning goal, starting point, mathematical learning, and conjecture of students' thinking. In this chapter, we elaborated HLT that involve 5 activities in a learning sequence of map understanding related to the spatial thinking particularly spatial orientation. Spatial orientation is one of the main component of spatial ability that allows children to learn about orientating themselves, to take different perspective, to describe routes, to understand the shape/figure and realize the spatial relationship between objects (van Nes & de Lange, 2007). These activity emphasize the three mathematical question that is related to the map problem (Clements & Samara, 2009) are (1) Which way? (direction), (2) Where? (location), and (3)What objects? (Identification). The development of the children's thinking is started from map reading to map making followed by communication in using a map. Therefore, the first activity is about map reading of school map and the last activity is map making from a miniature zoo.

4.1 Lesson 1 : Read a school map

Learning goal

- Students understand their own school map
- Students can read their school map

• Students can realize the position of others room according to the school map.

Starting point

- Students recognize the shape square as a room on the map.
- Students realize position of their class on the map.

Classroom culture

- 1. Teacher asks students to raise their hand if students want to ask question.
- 2. Teacher encourages students to tell their opinion.
- 3. Teacher will raise her hand as a sign to silent.
- 4. Students should work in team work.

Description activity

This activity offers the experience of map reading for students to do activity by using a school map to find the certain room on it. Students should realize the position of the room on the map and follow the path. Also, this activity provide opportunity for students to understand the symbol or pictorial figure on the map

1. Introduce the school map and tell the problem



Figure 4.1 The school map

The problem: A pupil fell and she injured. Therefore, a teacher asks students to go from Kelas II to UKS (School health program) room for taking the first aid box. They will find that room based on the given map.

Students' conjecture

- Students will use a school map to find UKS room.
- They will work in group of 4 to discuss about what they understand and interpret the map. For example, where is their position on the map? Or the meaning of pictorial figures on the map.
- Later, they will discuss about the way to go UKS room.
- A few groups might have different way to find the way of UKS room.
- 2. Teacher generates the discussion about:
 - a. Is it easy to find UKS room?
 - b. How do students understand about the map?
 - c. How do students find the UKS room?
 - d. What are the rooms that they pass during the way to UKS?

3. Teacher compares which group is the fastest and the slowest group that find

UKS room.

4. The fastest and the slowest group talk their experience by using a map.

Students' conjecture

- Students can read a map easily because they recognize the position of the object in the map to the real condition.
- Students who can read a map easily will follow the path in the map to find the room.

- Students understand the pictorial figures on the map.
- Students have difficulty to realize the position in the starting point.
- Students get lost when they follow the school map to find the room.
- 5. Closing the lesson

Teacher reflects the lesson by asking some questions:

- What do we learn?
- What is the important to learn about read a map?
- What is your strategy to read a map easily?

4.2 Lesson 2 : Left Versus Right

Learning goal

- Students understand about the term of orientation, such as forward, go back, left and right.
- Students are able to distinguish between left and right.
- Students can find the position of certain object by using orientation term.

Starting point

- Students have already heard about the term of orientation.
- Students have already known the position of objects.

Description activity

In the previous activity, students have already experience outside about finding the room. They realize the position of the rooms in the school map. In this activity, students know the position of their friend according the classroom map. Also, they find the position of students sitting based on the instruction that using term of orientation. Therefore, this activity encourage student to realize about the orientation.

Before discuss about classroom map, students have a little experience to move their body by simple instruction of orientation.

1. Classroom experience

In the beginning activity, teacher asks students about the term of orientation:

- Have you ever heard about go forward/go back/turn the left/turn the right?
- Can you give me the example of direction sentence of certain object?
- Where does student A sit?

In this activity, students do it outside the class. Students have experience by moving their body according the instruction from the teacher, such as:

- a. Turn the left
- b. Turn the right
- c. Go forward 3 steps
- d. Go back 2 steps

This activity be held for all students in the class during 5 minutes.

Students' conjecture:

1. Some students move correctly based on the instruction, especially go forward and go back.

2. Some students have difficulty to turn the left and the right.

Teacher's Action

Teacher tells the students who have difficulty to follow their friend's movement in turning the left or right.

2. Classroom discussion

There is a classroom discussion after they have experience on moving their body. Topic discussion:

- 1. Why can some students not distinguish between left and right?
- 2. How do students distinguish between left and right?
- 3. Can you tell your way to do it?

Student's conjecture:

- Some students consider their hand as the sign, such as right hand to write, so another hand is left hand.
- b. Use the position of object, such as a watch is on the left hand side.
- 3. Work about classroom map in group

Teacher said that she needs students' help to make a classroom map to know the position of the students.



Figure 4.2 Classroom map

- 4. After they finish work on classroom map, teacher asks students to look the classroom map that they have done and realize the position of some students, here are some question about students' position on the classroom map such as
 - a. Who does sit on the right of student A?
 - b. Who does sit on the left of student B?
 - c. Who does sit behind of student C?
 - d. Who does sit in front of student D?
 - e. Who does sit on the two steps to the right of student E?
 - f. Who does sit on the three steps to the left of student F?
 - g. Who does sit on the two steps to the forward of the student G?
 - h. Who does sit on the two steps behind of student H?
 - i. Who does sit on the three steps to the right and two steps forward of students I?

Students' conjecture:

Students answer in the paper A4 for each question and show the answer. It can generate the classroom discussion whether students answer correctly or not about how they answer the question according to the instruction on the question.

5. Closing the lesson

Teacher reflects the lesson by asking some questions:

- What do we learn?
- What is the important to learn about directional term such as left, right, forward, and go back?
- What is your strategy to distinguish left side and right side?

4.3 Lesson 3 : The map of palace

Learning goal

- Students get better understanding about direction.
- Students learn about simple navigation.

Starting point

Student are able to use and distinguish the left and the right side.

Description activity:

In the previous activity, students have already learned and about the term of orientation, such as left, right, etc. Those terms are used in this navigational game

that uses the map of palace. When, they play this game, students use such of puppet to help them follow the direction.

Story: The king will tell you the room of palace. However, there is a blank map and you have to fill the name of the room. By using the puppet, you will enter the palace and give the name of the room on the map.



Figure 4.3 The map of palace

 Students play a navigational game. In this game, teacher gives direction for the students to fill the name of the room on the map of palace



Figure 4.4. The instruction

2. Students put their map of the palace on the white board.

The Answer:



Figure 4.5 The answer

- 3. Students look the others' map and find the differences. Then, teacher can generate classroom discussion:
 - Is there a different map?

- What is the difference?
- Why is it different?
- 4. Classroom discussion

Students' conjecture:

- a. There is a different map because students write the name of the room in the wrong place. It is caused of wrong orientation (i.e. left and right).
- b. It must be consistent with the direction.
- c. It must be in the same direction view.

Teacher's action:

Teacher asks about the possibility to have a such condition: (Lounge is in the left of living room).

Lounge	Living	Lounge
	room	

4.4 Lesson 4 : The Puzzle of Map

Learning goal

- Students get better understanding about identification.
- Students make a simple route in finding the way.

Starting point

Students understand about direction.

Description activity:

In the previous activity, students are able to understand the direction by using the orientation term. For this activity, students identify the object by realizing the position of animal whether it is on the left or right side. Students use such a puppet for help them to imagine the real situation in the previous activity, but in this activity, students do not use puppet, so they have to keep hold the left side and the right side of the turtle.

In the beginning of activity, students work on the puzzle. They have a little discussion about how to arrange the puzzle. Indeed, students need to identify the pieces of puzzle in arranging the puzzle.

- 1. Teacher tells the story about the sea world.
- 2. Teacher introduce the problem

The first problem: What are the sea animal on the puzzle?

3. Students must arrange the puzzle to answer the first problem.



Figure 4.6 The puzzle

4. After students answer question about the animals on the puzzle. Teacher asks students How they arrange and finish the puzzle.

Students' conjecture:

- a. Students do it by trial and error.
- b. Students consider imperfect picture on the edge for the each part of the puzzle.
- c. Students find the corner part of the whole puzzle to start the arranging of puzzle.
- 5. Next, Teacher tells the story of the turtle on the puzzle. *The second problem:* Help the turtle to find his friends?
- Students work in the group to draw the route of the turtle.
 Students' response:
 - a. Students make the way that is only passed by the turtle



Figure 4.7 Students' response 1

b. Students make all the bend of the way although it is not passed by the

turtle



Figure 4.8 Students' response 2
7. Students write the name of the animals that is met by turtle during his way to find his friend. It will encourage students to consider about the other objects on the path and put them in the proper location.



Figure 4.9 Students' response 3

8. Students will determine the position of the other animal according to the left and right side of the turtle. Based on the second and third activity, students are able to recognize the position of the certain object through considering the left and right side.

Students' conjecture:

a. Students will answer correctly

On the left side	On the right side
Crab	Sea star
Zebra fish	Anemone
Angel fish	Clown fish

b. Students will answer in reverse way which is incorrect answer.

On the right side	On the left side
Crab	Sea star
Zebra fish	Anemone
Angel fish	Clown fish

4.5 Lesson 5 : The zoo map

Learning goal

- Students realize the position of the objects.
- Students can communicate and give the direction to find certain object
- Students make a simple map

Starting point

Students understand about orientation and direction.

Description activity:

In the beginning of activity, students will create the miniature zoo. This zoo be used as a representation of the place that will be explored .In the previous activity, students have ability about orientation and direction. In this activity, students are encouraged to communicate the idea of orientation and direction through guiding their friend in finding the way of animal in the zoo.

- Teacher asks students to have a role play as an owner of the new zoo. Students will make a good arrangement of some animals, pond, and parks in the zoo.
- 2. Students work in group. Students arrange the miniature of the zoo on the board which is an area of the zoo.



Figure 4.10 The board



Figure 4.11 The stuff for miniature

- 3. Students come up with different arrangement of miniature zoo.
- 4. Students can explore their miniature zoo.

Students' conjecture:

- Students explain the arrangement of their own zoo.
- Students can start to illustrate the position of the animals from the gate of zoo. For example, the position of tiger is on the right side of lion

- Students use the direction and orientation knowledge from the previous lesson to figure out the position of the objects. It means that students have to communicate by giving the correct direction.
- The miniature of zoo is a kind of representation 3-dimensional place. Next, students deal with 2-dimensional place.
- 6. Students take the animals and other stuffs from the board and just write down those things on the board. For instance,



Figure 4.12 Students' answer

- Next, teacher tells to the students that as an owner of the zoo, they have to make a map for the visitors in the zoo. Students will make a simple map of their zoo on the worksheet.
- 8. Students explain their map to other friend (as the visitor) who has different arrangement. Students should communicate their map clearly.

CHAPTER V

TESTING HLT

In this chapter, we analyzed the whole data that were collected from preparation phase until teaching experiment. The teaching experiment in the first and second cycle was accomplished in Madrasah Ibtidaiyah Negeri 2 Model Palembang. To investigate and explain students' thinking about the map activities in supporting the development of spatial ability, the hypothetical learning trajectory is used as a guideline in the retrospective analysis. Thereafter, the analysis process is focused in detail with attention to research question and how the design works.

5.1 Analysis of the teaching experiment for the first cycle

In this phase, the researcher worked with 5 students as participants who have different level thinking in mathematics. They are the high achiever students (Bagus and Bima), the average students (Farhan), and the low achiever students (Fadli and Farraz). The response of students in the first cycle of teaching experiment would give us feedback to improve the hypothetical learning trajectory for teaching experiment in the second cycle.

5.1.1 Pre Test

The purpose of the pre test is to know the prior knowledge of students about the map understanding which are map reading and map making. There are two kinds of question for the pre test, namely written and oral test. The written test consists

of 4 questions meanwhile the oral test is only one question about students' communication which is asking students to tell their own map to other friends.

For the first question in the written test, it is purposed to know how student can memorize the position and location of the object from the certain map (Figure 5.1). However, some students are not patient to open the next page, and start to answer the question or open again the previous page to see the location object so it seemed that they do not memorize the position and location of the object while it is the purpose of this question. Therefore, all of students could answer the question correctly. The result of this question could not use to be analyzed in understanding the prior knowledge of students about memorizing the location of object.



Figure 5.1. The first question of pre test

The second question is to know how students can distinguish left and right hand through identifying those pictures (Figure 5.2).



Figure 5.2. The second question of pre test

Some of students use their hand to answer the question. They attempted to compare between the figure of the hand and their hand directly. The result shows that some students can answer it correctly and only a few of them cannot distinguish that picture whether it is left or right hand.

The purpose of the third question is to know how students determine the location of particular object after it moves according to the direction. For the last sub question about description of an object, all of students did not have an idea and misunderstanding about that question so the students cannot answer properly. In addition, some of students could not get the right perspective of the object in the question. Therefore, this question should be revised. It is necessary to put the perspective sign in this question.

Beside the written test above, the researcher also asked students to make a map from their house to the school. Students drew the map in 5 minutes. They drew it on the paper A4. All of students could draw the route from house to school even it is the simple route. It shows that students can imagine the route and identify some objects that are met during the way from house to school for instance, students draw shop, office, or trees. The purpose of the question in this part is not only asking students to make a simple map but also students have to communicate their map to their friend. They attempted to give the direction and shown the map to their friend. Only Bagus and Farhan can communicate their map fluently. It seems that other students still struggle to give direction and communicate their map for others.

No	Name	Question												
		Nu	nber 1			Number 2					Number 3			
		1	2	3	1	2	3	4	5	6	1	2	3	4
1.	Farhan	\checkmark				\checkmark		\checkmark	-		\checkmark	\checkmark	-	\checkmark
2.	Bima	\checkmark			-	-	-	-	\checkmark	-	\checkmark	\checkmark	\checkmark	\checkmark
3.	Fadil	\checkmark	-	-		\checkmark	\checkmark	\checkmark	\checkmark		\checkmark	\checkmark	-	-
4.	Farrraz	\checkmark	-	-		\checkmark	\checkmark	\checkmark	-	-	\checkmark	-	-	\checkmark
5.	Bagus	\checkmark		\checkmark		\checkmark	\checkmark	\checkmark	\checkmark		\checkmark	\checkmark		-

Table 5.1The result of the pre test in the first cycle

According to the table above, we can see that some students still did mistake for the question number 1 about memorizing the location of the object on the map. Two students got fail to memorize 4 objects on the map. For the second question, it is about distinguishing the left and right side. Only two students could answer correctly the entire sub-question. However, two other student who are not answer correctly the entire sub-question, they just did one or two mistake. Bima is the only one student who can answer 1 question correctly. For the last question, it is about direction. The result show that some students still did mistake even one or two sub-question.

5.1.2 Activity 1: The school map

The main purpose of the first activity in this lesson sequence is to provide an experience in reading a school map. According to the initial HLT in the chapter 4, there is a problem about finding the UKS (School health program) room and taking the first aid box there. The school map is given as a tool to find out that room. However, in the pilot experiment, the UKS room is near to students' class. It seems that students do not need a map to find it because they have already known the position of UKS. Then, the researcher changed the problem into finding a star in a certain place and students have to read a map to know the location of the star.

In this activity, students worked in pair. At the beginning, students were asked about their understanding and interpretation of the given map which is their own school map. Students could explain the position of the room on that map. For instance, students pointed out the room on the map and gave the description and direction about that location. It seems that students realize the position of certain object in school map, such as teacher room, toilet, etc. The students' understanding about the position of the object is related to the mathematical question on the map that is where (location). In this pilot experiment, it shows that students in low grade have the ability to understand the location on the map. In addition, related to another mathematical question on the map about what object (identification), students could explain the pictorial figure on the map, such as rectangle as a representation of the class. Understanding the pictorial figure and location of the objects on the map leads students to generate the different way in finding the star (Figure 5.3.) since they can realize the meaning of those figure on the map.



Figure 5.3 Student draws the different route

The ability to identify object in reading a map is important because it is helpful for interpreting the map correctly. Students in low grade have this kind of ability. The following transcript showed it.

1	Researcher	: How do you find the star? Can you tell me the route?
2	Fadil	: First, pass this way and turn and turn again, then just go
3		straight forward.

4	Researcher	: How many ways do you find to get the star?
5	Fadil	: Two ways
6	Researcher	: are you sure?
7	Fadil	: Yes, this is another ways (Show the route)
8	Researcher	: Why do you take this way?
9	Fadil	: Hmm, because I know that there is a path between those
10		rooms and we can walk there.
		Transcript 1.

When student gave the direction (line 2 & 3), students attempted to orient their body and explain the meaning of the line which is representation of the route to find the hidden object. Besides, it shows that student realized the path as an object between those rooms (line 9). Moreover, they recognized the location of objects there. Hence, students can understand and read a map to find a star. Furthermore, they could find the different way to find the star (line 7). However, considering the group discussion in this small group, students are still less discussion with their pair. Students tend to work individually. The role of teacher to encourage student in group work and discussion is important.

5.1.3 Activity 2 : Left versus Right

The second activity is aimed to give an understanding the term of direction such as left and right. Firstly, students moved their body by following the instruction for instance turn the left or turn the right. A few students did a mistake, but they saw their friend and followed them. According to the observation in this small group, two students still struggled to follow the direction in moving their body in which turn the left or turn the right. It seems that those students still cannot distinguish between left and right. Then, the researcher asked students who moved properly based on the direction.

1	Researcher	: How do you move correctly?
2	Farhan	: Um, Just turn the left and right
3	Researcher	: What do you mean?
4	Farhan	: I see my hand, if it is turn the left, I look at my left hand and
5		if I turn the right, I look at my right hand
		Transcript 2

This strategy to distinguish is suitable with the conjecture in HLT. Students use their hand which one is left and right hand in order to follow the instruction in moving their body (line 4 and 5). On the other hand, the other students could not tell the different way to know the left and right side. This activity could leads students to be able in understanding the direction such as turn the left and right.

After they had an experience and insight about left and right side, the researcher gave the classroom map. According to the HLT, students have to write down the name of their classmate in the blank classroom map. The aim of giving the blank classroom map is to stimulate students and to realize the basic idea of the position. Nevertheless, that activity could be not accomplished because the researcher only involved 5 students and undertook the lesson in the library. Therefore, it is not relevant with the situation and condition of the small group in the first cycle. Then, the researcher just gave the classroom map that is not a blank classroom.

The researcher asked student to answer the question related to the moving a certain objects in classroom map. In the beginning, students were encouraged to realize the position of the objects on that map such finding the position of student in the classroom map. Subsequently, the questions are about the new position of the object after it moves based on the given direction. All of students have no difficulty to answer this question about students' position in the classroom map. Students looked the position of the students on the classroom map and used their finger to point out the position of the objet. Likewise, to follow the given direction, students still used their finger to deal with it. This finding shows that the students has already known about the position and its moving which is related to the fundamental knowledge in spatial orientation. Spatial orientation considers the point of view to know and determine the position of the object.

5.1.4 Activity 3 : The map of palace

In the previous activity, students have already learned to distinguish left and right side. The next activity is that student played a simple navigational game. In this activity, students worked in a group consisting of 2 students. They were asked to fill the name of room on the map palace based on the instruction. Almost students could answer it correctly. It seems that the students did not face the difficulty to play this navigational game since the students have already deal with the direction in the prior activity. It shows that there is continuity among activities.

At the end of activity, the researcher asked two students to tell again and explain about the room in the map of palace by using their own sentence. By using their own sentence, students required the understanding to navigate the position of object in every step they take in explaining the room on the map of palace. It shows that students started to develop the spatial orientation.

1	Researcher	: can anyone tell again about the position of the room in the map
2		palace?
3	Fadil	: I can
4	Researcher	: Yes, let's go. The king enter the palace then
5	Fadil	:The king enter the palace, go straight forward, it is a living room,
6		turn the left is lounge, and left again is king's room. In front of
7		king's room, there is a dining room, then turn, it is study room.
8		
9	Farhan	: Turn the left or turn the right?
10	Fadil	: Turn the right, it is study room. Turn the right of study room,
11		there is a kitchen. The right side of living room is music room and
12		princess' room.
		Transcript 3.

The transcript above shows that Fadil is able to describe the position of the room by using the direction term, for instance turn the left and right (line 5 to 8). The navigational game provides the opportunity for students to enhance the basic ability in spatial orientation since students will be able to orient spatially with respect to a given object or scene. Students could realize their position Therefore, students still require more opportunity to improve and support the development of spatial ability based on the level age.

5.1.5 Activity 4 : The puzzle of map

The lesson was started by playing the puzzle of the turtle. The purpose of puzzle game is to engage students in identifying the piece of puzzle and arranging them become a proper picture. However, in actual learning of pilot experiment, students had difficulties in arranging the pieces of puzzle. The researcher observed that the most difficulty is to find the piece on the corner of the whole figure. Some students need a long time to do it. Some of student accomplished through trial and error strategy. They attempted to figure out finding the correct piece to get the complete figure. The fastest student who could finish the puzzle needs 15 minutes. Whereas the researcher conjectured that the maximum time to do it is only 10 minutes.

After they finished the task of puzzle, students need to find and draw the way of turtle's problem. The aimed of this problem is to stimulate and to consider the aspect of mathematical questions in solving the problem about the map which are what object (identification), which way (direction), and where (location). Students were asked about the way to find his friend based on the given map. It can prompt students to consider about direction. Two of three groups could answer properly, but one group just wrote all the way in the map. These responses are suitable in students' response of our HLT. Next, students had to deal with the question about locating the object in students' drawing that is fit to the correct location on the given map. Entire groups have already recognized the location of object from the given map.

Identification object is accomplished through the question about what object that turtle meet during his journey and make a group of animal based on the position whether it is on the left or right side. Students required the orientation during the turtle's route to classify the position of object. Likewise, they need to keep the point of perspective.

1	Researcher	: Can you tell me the route?
2 3 4	Farhan	: go straight, turn the left, go straight, turn the left, go straight, turn the right, go straight. Turn the right, turn the left, and turn the left

From the students' explanation, it seems that student has already known the route and could give the appropriate direction. Farhan imagined the movement of turtle along the route. This ability is necessary to build the mental imagery and orientation of students. The mental imagery and orientation refers to anything and everything that happens inside when students are thinking, considering and reflecting the orientation from the given map.

5.1.6 Activity 5 : The zoo map

The last activity of the learning sequence is intended to know students understanding about arrangement the location of object and make a simple map from that arrangement. The context for this activity is about making your own zoo. Students were given a large paper as a board of zoo and some miniature of animal and pond, Students put that stuff on the board of zoo. After that, students played giving the direction to reach the position of animal. They give the direction from the gate to the animal cage. The knowledge of direction and orientation that they have gotten from the previous activity is encouraged to be used for this game.

According to the observation, students could not communicate and give the direction properly. They still struggled to differ whether they have to turn the left or turn the right. Likewise, the arrangement of miniature animal did not support students to give direction well. It seems that students have difficulty to put the miniature on the board zoo in the proper position so that they cannot navigate to give the correct direction. At the end of the activity, students took the miniature animal and just write down the name of animal on the board zoo. Later, students are asked to make that zoo map on another paper (Figure 5.4). That zoo map shows the arrangement of animal on the board zoo.



Figure 5.4. Zoo map

5.1.7 Post Test

The post test was given to know the development of spatial ability after the learning sequence. The question of post test is similar to the question of pre test. Overall, the result shows that there is the difference between the pre test and post test. For the first question, students can do it better than pre test. Students could memorize the location of object from the given map. Similarly, for the second and third question, students have already could distinguish the left and right side. Nevertheless, the response student for the question of making a map from the house to school is not good. They said that they have already made the map before so they did not make a map better than before.

5.2 Conclusion for the preliminary experiment (first cycle)

From the implementation of the design in the small group, the researcher did reflection and concluded for each activity as follow:

1. Activity 1 : The school map

In this activity, the problem is about taking the aid box in healthy room by looking in the school map. However, this room is easy to find. The purpose of the first activity is to give the experience for students by solving the problem related to the school map so students can read and understand the school map. Therefore, it is necessary to change the problem in this activity. Based on the discussion between teacher and researcher, we would ask students to find some stars that are spread out in the school. Students will be given a map that shows the location of the stars.

2. Activity 2 : Left versus Right

As my conjectures, there are students who are able and unable to distinguish left and right side. However, students cannot tell their strategy

to distinguish left and right side. They have difficulty to communicate their reason so teacher should encourage students through scaffolding question in order to say their thinking. Therefore, the teacher should encourage students to tell their thinking.

3. Activity 3 : The map of palace

In the previous activity, students have already known about direction, such as left and right side. Therefore, there is no problem with the third activity. Students can follow the simple navigation to fill the name of room in the palace according to the instruction.

4. Activity 4 : The puzzle of map

Puzzle is one of the games that support the spatial ability. However, puzzle is not necessary to this learning sequence because it wastes the time so students do not have enough time to discuss the goal of this activity that is identifying the object and making a simple route. Therefore, the researcher will not use puzzle for this activity in the teaching experiment.

5. Activity 5 : The zoo map

Students cannot work well with the zoo context. It seems that zoo context that has been created is inappropriate problem for students to achieve the goal of activity: (a) realize the position of object, (b) communicate and give the direction to find certain object, and (c) make a simple map. So, the researcher needs to create the appropriate problem which is related to the previous activity.

6. Pre test and Post test

In this cycle, the researcher intended to give the same question between pre and post test. However, students give the response that is not good when they did the post test. It is caused by their mind set that they have already worked with the same question in the pre test. Therefore, the researcher need to change the question but it still has similar purpose for each question.

Some of the activities in the learning sequence should be revised by considering the response of the student in the pilot experiment. In addition, the question between pre test and post test should be different even though it still has same purpose for the each question.

5.3 The refined Hypothetical Learning Trajectory

5.3.1 Activity 1 : Read a school map

Learning goal

- Students understand their own school map
- Students can read their school map
- Students can realize the position of others room according to the school map.

Starting point

- Students recognize the shape square as a room on the map.
- Students realize position of their class on the map.

Description activity

This activity is aimed as the experience of map reading for students to do activity by using a school map to find some stars in the some certain location in the school. Students should realize the position of the room on the map and follow the path. Likewise, this activity provide opportunity for students to understand the symbol or pictorial figure on the map

1. Introduce the school map and tell the problem



Figure 5.5 The school map

The problem: Students has a role as a detective that has to find 7 stars in the hidden place of the school. The school map is a tool as guide to find those stars. Students must take stars in 15 minutes. Students will work in group. How is the fastest group to find 7 stars?

Students' conjecture:

- Students will use a school map to find 7 stars.
- They will work in group of 4 to discuss about what they understand and interpret the map. For example, where is their position on the map? Or the meaning of pictorial figures on the map.
- Students will understand and interpret the map by realizing the position of the classroom and the star.
- Later, they will discuss about the way to find the star.
- A few groups might have different way to find the way of the star.
- 2. Teacher will generate the discussion about:
 - a. Is it easy to find the star?
 - b. How do students understand about the map?
 - c. How do students find the star?
 - d. What are the rooms that they pass during the way to first star that they get?

3. Teacher will compare which group is the fastest and the slowest group that collect the star.

4. The fastest and slowest group will talk their experience by using a map.

Students' conjecture:

- Students can read a map easily because they recognize the position of the object in the map to the real condition.
- Students who can read a map easily will follow the path in the map to find the room.

- Students understand the pictorial figures on the map.
- Students have difficulty to realize the position in the starting point.
- Students get lost when they follow the school map to find the room.
- 5. Closing the lesson

Teacher reflects the lesson by asking some questions:

- What do we learn?
- What is the important to learn about read a map?
- What is your strategy to read a map easily?

5.3.2 Activity 2 : Left Versus Right

Learning goal

- Students understand about the term of orientation, such as forward, go back, left and right.
- Students are able to distinguish between left and right.
- Students can find the position of certain object by using orientation term.

Starting point

- Students have already heard about the term of orientation.
- Students have already known the position of objects.

Description activity

In the previous activity, students have already experience outside about finding the star. They realized the position of the rooms in the school map. In this activity, students know the position of their friend according the classroom map. Also, they find the position of students sitting based on the instruction that using term of orientation. Therefore, this activity will encourage student to realize about the orientation.

Before discuss about classroom map, students will have a little experience to move their body by simple instruction of orientation.

a. Classroom experience

In the beginning activity, teacher will ask students about the term of orientation:

- Have you ever heard about go forward/go back/turn the left/turn the right?
- Can you give me the example of direction sentence of certain object?
- Show me your right hand?

In this activity, students will do it outside the class. Students will have experience by moving their body according the instruction from the teacher, such as:

- a. Turn the left
- b. Turn the right
- c. Go forward 3 steps
- d. Go back 2 steps

This activity will be held for all students in the class during 5 minutes.

Students' conjecture:

1. Some students will move correctly based on the instruction, especially go forward and go back.

2. Some students will have difficulty to turn the left and the right.

Teacher's Action

Teacher tells the students who have difficulty to follow their friend's movement in turning the left or right.

b. Classroom discussion

There will be a classroom discussion after they have experience on moving their body. Topic discussion:

- 1. Why can some students not distinguish between left and right?
- 2. How do students distinguish between left and right?
- 3. Can you tell your way to do it?

Student's conjecture:

a. Some students consider their hand as the sign, such as right hand to write, so another hand is left hand.

b. Use the position of object, such as a watch is on the left hand side.

c. Work about classroom map in group

Teacher said that she needs students' help to make a classroom map to know the position of the students.



After they finish work on classroom map, teacher asks students to look the classroom map that they have done and realize the position of some students, here are some question about students' position on the classroom map such as

- a. Who does sit on the right of student A?
- b. Who does sit on the left of student B?
- c. Who does sit behind of student C?
- d. Who does sit in front of student D?
- e. Who does sit on the two steps to the right of student E?
- f. Who does sit on the three steps to the left of student F?
- g. Who does sit on the two steps to the forward of the student G?
- h. Who does sit on the two steps behind of student H?
- i. Who does sit on the three steps to the right and two steps forward of students I?

Students' conjecture:

Students will answer in the paper A4 for each question and show the answer. It can generate the classroom discussion whether students answer

correctly or not about how they answer the question according to the instruction on the question.

d. Closing the lesson

Teacher reflects the lesson by asking some questions:

- What do we learn?
- What is the important to learn about directional term such as left, right, forward, and go back?
- What is your strategy to distinguish left side and right side?

5.3.3 Activity 3 : The map of palace

Learning goal:

- Students will get better understanding about direction.
- Students will learn about simple navigation.

Starting point

Student are able to use and distinguish the left and the right side.

Description activity:

In the previous activity, students have already learned and about the term of orientation, such as left, right, etc. Those terms will be used in this navigational game that uses the map of palace. When, they play this game, students will use such of puppet to help them following the direction.

Story: The king of Kesultanan Palembang Darussalam will tell you the room of palace. However, there is a blank map and you have to fill the name of the room. By using the puppet, you will enter the palace and give the name of the room on the map.



1. Students will play a navigational game. In this game, teacher will give direction for the students to fill the name of the room on the map of palace



2. Students put their map of the palace on the white board.

The answer



3. Students look the others' map and find the differences. Then, teacher can generate classroom discussion:

- Is there a different map?
- What is the difference?
- Why is it different?

4. Classroom discussion

Students' conjecture:

a. There is a different map because students write the name of the room in the wrong place. It is caused of wrong orientation (i.e. left and right).

b. It must be consistent with the direction.

c. It must be in the same direction view

5.3.4 The fourth activity "A simple route"

Learning goal:

- Students will get better understanding about identification.
- Students make a simple route in finding the way.

Starting point

Students understand about direction.

Description activity:

In the previous activity, students are able to understand the direction by using the orientation term. For this activity, students will identify the object by realizing the position of animal whether it is on the left or right side. Students use such a puppet for help them to imagine the real situation in the previous activity, but in this activity, students will not use puppet, so they have to keep hold the left side and the right side of the turtle.

- 1. Teacher tells the story about the sea world.
- 2. Teacher introduce the problem

The first problem: What are the sea animal on the puzzle?



- 3. After students answer question about the animals on the puzzle.
- 4. Next, Teacher tells the story of the turtle on the puzzle.

The second problem: Help the turtle to find his friends?

5. Students work in the group to draw the route of the turtle.

Students' response:

a. Students will make the way that is only passed by the turtle



b. Students will make all the bend of the way although it is not passed by the turtle



6. Students write the name of the animals that is met by turtle during his way to find his friend. It will encourage students to consider about the other objects on the path and put them in the proper location.



7. Students will determine the position of the other animal according to the left and right side of the turtle. Based on the second and third activity, students are able to recognize the position of the certain object through considering the left and right side.

Students' conjecture:

a. Students will answer correctly

On the left side	On the right side
Crab	Sea star
Zebra fish	Anemone
Angel fish	Clown fish

b. Students will answer in reverse way which is incorrect answer.

On the right side	On the left side
Crab	Sea star
Zebra fish	Anemone
Angel fish	Clown fish

5.3.5 The fifth activity "Finding the way"

Learning goal:

- Understand the common map in daily life.
- Solve the map problem.

Starting point

Students understand about orientation and direction.

Description activity:

In this activity, students solve some problems that related to a given map.

1. Teacher gives the map of Palembang



Peta Lokasi di Palembang

2. Students are encouraged to explain the information that they get on the map.

Students' conjecture:

a. There are streets, buildings, shops, etc on the map

- b. There are some routes to find the certain location of object.
- c. There is the shortest route and the longest route.

3. Student work in pair to solve 4 problems related to a given map (Map of Palembang)

Problem 1: Ms Elika walks along Basuki Rahmat Street. Write down all the object that is met by Ms Elika along that street?

Problem 2: Ms Elika will go from Polda to Airport. Draw the route and the object along the route?

Students' conjecture:

1. Students just draw the line as the route from Polda to Airport

2. Students draw the line and the name of its street.

3. Students draw the line, the name of its street, and the object along the route (RS Mata, Pasar, RS Jiwa, etc).

Problem 3: Ms Elika lives at Perumahan Asri. She will visit her friend in RS Hermina. How many possible ways/route for that situation? *Students' conjecture:*

- 1. One way
- 2. Two ways
- 3. Three ways

Problem 4: According to your answer in the previous problem, choose one route that is the shortest route. Draw it!

Students' conjecture:

- 1. Students can find the shortest way
- 2. Students choose another way that is not the shortest way.

5.4 Analysis of the teaching experiment for the second cycle

Before conducting teaching experiment in the second cycle, we did classroom observation for one lesson of mathematics in the class of teaching experiment. There are some points that are considered during observation such as students' activity, teacher's role, teaching and learning process, social norm, and sociomathematical norm. According to the observation, teaching and learning process is quite well. Teacher stated the lesson by giving some problems. After students finished it, the teacher asked students to write their solution on the board. Teacher also encouraged some students to explain their strategy and asked other students who have different solution. Indeed, some students are active enough during the classroom observation. It seems that the teacher has already attempted to construct good sociomathematical norms in her class before.

Beside classroom observation, the researcher also conducted interview with teacher after doing classroom observation. In this interview, the researcher obtained the information related to the background of teacher, instructional skill, classroom management and the specific topic about spatial ability. According this interview, the teacher has already joined some workshop of PMRI. She is really agreed with the characteristic of PMRI. Therefore, she used PMRI as an approach in teaching and learning process, for instance, using the context as starting point, involving students in classroom discussion, or encouraging students to contribute their own strategy or solution.

The teaching experiment for second cycle was conducted from March 18th to March 23rd, 2013, and the researcher worked with 35 students as participants who have different level thinking in mathematics. They are 15 boys and 20 girls. They involved from the pre test, learning sequence to post test. The teacher used the refine HLT. Before conducting the teaching experiment for the second cycle, the researcher and teacher discussed every material and teacher guide for each meeting.

5.4.1 Pre test

The pre test consists of 3 written question: (1) Memorize the location of object on the map, (2) distinguish left and right, and (3) understand the position of the object. The following table shows the result of pre test. For the first question, students answer the location of the object on the map after they were given 2 minutes to memorize the position of the object. To deal with the question number
2 and 3, students are hypothesized to use their prior knowledge about left and right.

Table 5.2

The result of pre test in the second cycle

						Que	stion						
-	Number 1			Number 2						Number 3			
	1	2	3	1	2	3	4	5	6	1	2	3	4
A number of students	23	20	18	15	18	22	22	20	21	33	28	16	15
who answer correctly													

According to the result of pre test, the students get the low score for the question number 2 and number 3. Especially, the question number 3 that is related to the moving object (turn the left or right) is quite difficult for students. It seems that students have less understanding about direction.

5.4.2 Activity 1: The school map

At the beginning of activity, students were asked about the position of the healthy room (UKS). This question is to provoke the mental imaginary of students. Almost students recognized the position of the UKS. Some students could answer in different perspective of UKS room.

1	Teacher	:Does anyone tell the position of UKS? Where is
2		UKS? Rafli
3	Rafli	: Beside the canteen

4	Teacher	: Is there any answer?
5	Azriel	: beside the class of 2.c
6	Teacher	: Haidir (student who put his hands up)?
7	Haidir	: Near to toilet
8	Teacher	: What about in front of UKS?
9	Lili	: school yard is in front of UKS
		Transcript 5

According to the fragment of video, the students' answer about the question where the positions of UKS are: (1) Beside the canteen (2) Beside the class of 2.c (3) Near to toilet and (4) Near to the school yard. Some students recognized the position of the UKS. Some students could answer in different perspective of UKS room by telling the different description of location. Students imagined the real position of certain object then they tried to figure out another object around it. It seems that students have the basic ability about identification and location object which are required in reading a map.

At the end activity, some students could find seven stars in the hidden location. As the purpose of this activity is to give the experience for students in reading a map, students enjoyed this outside activity. Based on the observation in teaching experiment, students tend to find the star in the familiar location first. They used the prior knowledge about the location of object on the school map. The general results are consistent with an analysis of map reading as divisible into some component (Clarke, 2003): (1) the ability of recognition through searching, location and identifying, (2) orient map by giving the direction, (3) recall from memory to generate different possible ways, and (4) inferential comprehension in reading a map. 5.4.3 Activity 2 " Left versus Right"

In the beginning of the lesson, the teacher asked students to show their left or right hand .As we conjectured that a few students still confuse to distinguish between left and right when they were showing the left and right hand. The following classroom discussion shows the students who did a mistake.

1.	Teacher	: who is sit in the leftmost and the first row? Write it down,
r	(Studants lo	please!
2	Teacher	: in the left and the first row (Peneat the question)
5 1	Students	: I have done (Students raised the paper to show their answer)
4 5	Tanchar	: Who does answer incorrectly? Just say honestly. I will give
5	reacher	the star to students who answer incorrectly
6	Students	· I do I do
7	(Teacher wa	lked toward the students who answer incorrectly)
8	Teacher	: What is your answer?
9	Rifda	: Shafa
10	Teacher	Why is your answer "Shafa"? The question is who sit in the
11		leftmost and the first row. Listen to your friend. Why do you
12		answer Shafa? (Teacher stood close to student asked her
		reason)
13	Rifda	: (not audible)
14	Teacher	Oh, Rifda thought just her left which is Shafa (point out Shafa).
15		But actually, the question is also about the first row. I give you
16		a star (draw a star in student's paper). Who else do a mistake?
17	(Teacher wa	lked to the back row)
18	Teacher	: Oh, your answer is Lili. Where is Lili?
19	(student poir	nted out Lili who sit in the right side)
20	Teacher	: Why do you answer Lili? Why?, Loudly, please. Listen to
		your friend, please.
21	Students	: (not audible)
22	Teacher	: Why ?Oh, they see Lili in their left side but actually Anisa is
23		in the left side. (Draw a star in student's paper). You are honest
24		student, good. Who else is wrong?
25	(Teacher wa	lked toward the boys students)
26	Teacher	: Your answer is Putra. Why is your answer "Putra'??
27	Students	This is Putra. in the left of the row is "Putra" (Point out Putra).
28	Teacher	Oh, Putra sits in the left of your group, but he is not the
		leitmost ior all.

Transcript 6.

Classroom discussion is the second main part in this activity. According to transcript above, the teacher encouraged some students to tell their misunderstanding in distinguishing left and right (line 10 & 11). Students did not understand with the leftmost, they just though the left side of them (line 27). Students still faced difficulty in language space which represents the spatial relation among objects on the map. Understanding the language of space is important for students in development of spatial ability.

Beside classroom discussion, students also worked to fill the name of student on classroom map. Students looked around the position of their friend and filled the name of student on classroom map. After that, students were asked about the position of their friend by looking classroom map. According to classroom observation, most of students could deal with this task.

5.4.4 Activity 3: The map of palace

The map of palace is kind of navigational game. Regarding the result in the pilot experiment, students could deal with this activity so there is no significant change for this activity. To follow the navigational game, the player should consider the starting point, then answering the first question properly because the first answer influences the next answer. The written work above shows that students' answer is wrong for the first answer. Consequently, students did a mistake for the next question.



Figure 5.6 The instruction on the map of palace



Figure 5.7 Written work of student

Students' answer (Translation)



Figure 5.9 The correct answer

From the student's written work above, we can see that student fail to determine the position of room for the first question which is the living room after we enter the palace from the door. Consequently, the position of the room in the next question is also wrong; we can look from the room in the left and side of living room. For this navigational game, we can conclude that the first step of the player is important to follow the next instruction.

In general result, most of students could overcome this navigational game. Students who took right first step and able to distinguish left and right side will follow the instruction easily. It seems that this navigational game shows students' understanding in navigating the object.

5.4.5 Activity 4 : A Simple route

From the previous activity, students showed their understanding about direction. in contrast, for this activity, most of student faced the difficulty to determine whether the object is in the left or right side from the moving object. It seems that students need to develop spatial orientation. Spatial orientation task requires the perceptual perspective of the person viewing the object is moved. Moreover, spatial orientation involves the comprehension of the arrangement elements to remain unconfused by the changing orientation in which a spatial configuration may be presented. The suggestion is that the person should understand a representation of changing from the certain object. For the second question, it is related to the how student can imagine the moving object and determine whether the object is in the left or right side. Particularly, this ability refers to spatial orientation. However, the following students' written work indicates that student classified the position of the object according the starting point not from moving point whereas the question is about the moving point.

:1. AZH Nama 21.07 Jubtu Tanggal : . bantu kura-kura nukan jalan 1 Kora-ku Gambarlah garis perjalanan kura-kura menemui temannya 1. Tulislah nama hewan yang ditemui kura-kura sesuai dengan posisi hewan tersebutl finith of Isilah nama-nama hewan tabel berikut berdasarkan posisi hewan yang ditemui kura-kura! Di sebelah kiri kura-kura Di sebelah kanan kura-kura Gurity kuda laut Bintany ilean higilan Ray 1 lean bully

Figure 5.10 student's written work

Regarding the students' conjecture of student, the student's answer above is not addressed in HLT. We did not predict that students consider the starting point to determine the position of the left or right side. In fact, many students did this mistake in the teaching experiment. It seems that students did not really understand the meaning of question (language space).

5.4.6 Activity 5 : Finding the way

The last activity is intended to solve the problem related to the common map in daily life for students. Students were given a map of Palembang (Figure 5.11). in this part, we considered three question from four question given.



Peta Lokasi di Palembang

Figure 5.11 A map of Palembang

Problem 2:

Ms Elika will go from Polda to Airport. Draw the route and the object along

the route?

The aim of this question is to ask student in drawing a route and provoke the idea of identification of object during the route. The following fragment shows the process of students thinking to solve the problem above.
1 Teacher : write down the name of street and object in your drawing?

		5 5
		drawing?
2	Rafli	: Ms Elika will go from Polda to Airport. Draw the route
3		and the object along the route? (Read the question). This is
4		an airport (point out the position of airport on the map)
5	Riswandipa	: This (point out the position of airport on the map)
6	Rafli	: From this (start to draw the route from Polda on the map)
7	Researcher	: Draw on student worksheet
8	Riswandipa	: (start drawing the route from Airport)
	-	Transcript 7
		-

The fragment video above showed that students could come up with different starting point to draw the route. Riswandipa tend to take airport as a starting point to solve the problem meanwhile Rafli considered Polda as a starting point. According to the question, we can consider Polda is a starting point but the episode above shows that it is possible to start from starting or finishing point of the route (line 8). However, starting to draw from the finishing point is not conjecture of students' thinking for this activity. Therefore, thinking in reverse way should be considered as one of students' thinking in solving the map problem.

Problem 3 :

Ms Elika lives at Perumahan Asri. She will visit her friend in RS Hermina.

How many possible ways/route for that situation?

This problem intends to generate students' thinking to realize the possible route

on the map to reach a certain position. The following fragment shows the process

of students thinking to solve the problem above.

1	Researcher	: How many ways
2	Fasli	: 2 ways
3	Researcher	: Why is it 2 ways?
4	(Student 1 sh	ows the ways)
5	Azriel	: 3 ways
6	Researcher	: So, how many ways, are there 2 or 3 ways?
7	Azriel	: 3 ways. This (showing the third way)
		Transcript 8

At the beginning, the first student just recognized two possible ways for that problem. Yet, the second students come up with different answer; he realized that there is one more possible way. He could show another possible way by pointing out it. So, there are three possible ways for that problem. These students' response has already been stated in HLT.



Figure 5.12 written work of student

The written work shows that Azriel is able to overcome with this question. He could find three different ways to reach the same finishing point. Next ,the last question, it is related to the third question which is that students should determine the shortest way from the possibility ways that they answer before. Azriel's work shows that he could deal with this problem through proper drawing of the shortest route (Figure 5.13).

 Dari beberapa garis perjalanan yang kalian buat. Pilihlah satu saja yang merupakan rute/cara/jalan terpendek/ Gambarkan di kotak berikut ini dan Tulis nama jalan dan objek/gedung sesuai dengan posisinya di sepanjang garis perjalanan yg kalian buat



Figure 5.13 written work of student

5.3.7 Post Test

Students were given post test after they have done the fifth activity. Students were given 10 minutes to accomplish this test. Similar to pre test, the post test consists of 3 written questions: (1) Memorize the location of object on the map, (2) distinguish left and right, (3) understand the position of the object and draw a route by following the direction. The purpose for each question between pre test and post test is same but there are difference problems between those test.

Comparing to the result between pre test and post test, the development of spatial ability particularly map understanding has increased slightly. The following table shows the result of post test.

Comparison between pre test and post test in the second cycle													
					Qı	iestio	n						
	Numb	er 1]	Numł	per 2				Numł	per 3	
1	2	3	4	1	2	3	4	5	6	1	2	3	4
23	20	18	-	15	18	22	22	20	21	33	28	16	15
25	23	19	23	19	22	20	22	23	23	32	34	23	21
	1 23 25	Numb 1 2 23 20 25 23	Number 1 1 2 3 23 20 18 25 23 19	Number 1 1 2 3 4 23 20 18 - 25 23 19 23	Number 1 1 2 3 4 1 23 20 18 - 15 25 23 19 23 19	re test and post test in the second c Que Number 1 I 1 2 3 4 1 2 23 20 18 - 15 18 25 23 19 23 19 22	re test and post test in the second cycle Question Number 1 Number 1 1 2 3 4 1 2 3 23 20 18 - 15 18 22 25 23 19 23 19 22 20	re test and post test in the second cycle Question Number 1 Number 2 1 2 3 4 1 2 3 4 23 20 18 - 15 18 22 22 25 23 19 23 19 22 20 22	re test and post test in the second cycle Question Number 1 Number 2 1 2 3 4 1 2 3 4 5 23 20 18 - 15 18 22 22 20 25 23 19 23 19 22 20 22 23	re test and post test in the second cycle Question Number 1 Number 2 1 2 3 4 5 6 23 20 18 - 15 18 22 22 20 21 25 23 19 23 19 22 20 22 23 23	re test and post test in the second cycle Question Number 1 Number 2 1 2 3 4 1 2 3 4 5 6 1 23 20 18 - 15 18 22 22 20 21 33 25 23 19 23 19 22 20 22 23 23 32	re test and post test in the second cycle Question Number 1 Number 2 Number 1 1 2 3 4 1 2 3 4 5 6 1 2 23 20 18 - 15 18 22 22 20 21 33 28 25 23 19 23 19 22 20 22 23 23 32 34	Vertication for test in the second cycle Question Number 1 Number 2 Number 3 1 2 3 4 1 2 3 4 5 6 1 2 3 23 20 18 - 15 18 22 22 20 21 33 28 16 25 23 19 23 19 22 20 22 23 23 32 34 23

 Table 5.3

 Comparison between pre test and post test in the second cycle

According to table above, we can see that there is the difference result between pre test and post test. For the first question, students can do it better than pre test. Students could memorize the location of object from the given map. Similarly, for the second and third question, students have already could distinguish the left or rightside.

Chapter VI

Conclusion and Suggestion

The purpose of the research is to contribute the local instruction theory of spatial ability particularly map reading. This chapter consists of (1) conclusion by answering the research question, (2) suggestion by considering the finding of the study, and (3) discussion.

6.1 Conclusion

"How can map activities support the development of spatial ability particularly map reading?."

In this research, we designed the learning sequence about map activities that is aimed to contribute the local instruction theory of spatial ability particularly map reading. Here, we describe briefly how map activities support the development of spatial ability particularly map reading for each activity:

• Read a school map

In the beginning of learning series, students need the real experience about how to read a map. A school map is one of the familiar maps that can be used for this activity because students can realize the position of the object on the map and they have already known the real situation of the map. They can figure out the representation of the object on the map such as giving the description of the position from the certain classroom. • Left versus right

Understanding the direction is helpful for students in reading a map because they can make a decision to find the right way and know precisely the position of the object on the map whether it is on the left side or on the right side. Students can be provoked the idea of the direction by using the classroom map. They can know the position of the students' sitting on the classroom map.

• The map of palace

In the previous activity, students have already experienced about turn the left or the right and known about distinguish left and right. Playing navigational game is one of the activities that can be used to get more understanding about direction such as left and right. Students have to consider the given direction and follow it.

• A simple route

This activity can develop students' understanding about how they can keep the point of view to get right spatial orientation and determine the position of the object whether it is on the left side or right side. However, according to the observation in the teaching experiment and the result of students' work, it shows that some of students still struggle to deal with the spatial orientation. It seems that students need more practice to get more understanding. • Finding the way

The last activity is aimed to ask students in solving the problem related to the given map. For instance, students have to see the possible different way or students have to find the shortest way.

In conclusion, students need the spatial ability implicitly in learning mathematics. Reading a map can help students to develop the spatial ability. They tend to realize and grasp the idea of identification the object, location, position, and direction. As an educator we should provide the experience for student in classroom activities to enhance the spatial ability that is related about map understanding. The result shows that even students in low grade have basic understanding about reading a map, such knowing the position the object on the school map. Therefore, we need to stimulate and facilitate to expand this basic spatial ability.

6.2 Suggestion

6.2.1 Realistic Mathematics Education

The learning sequence in this research is underlined the principle of the realistic mathematics education. The use of the contextual problem is emphasized in starting point of the activity. For instance, in this activity we used the map school and classroom map to be explored by students in reading a map. This study attempts to contribute local instruction theory of spatial ability particularly map reading which is lack attention in mathematics education. Therefore, teacher can implement the learning of map activities to support the development of spatial ability for students.

6.2.2 Further study

In this study, we found that students can grasp the idea about position through activities in reading a map. Understanding of position is important in starting of learning coordinate system. Therefore, we expect that another study will generate the learning trajectory of coordinate system regarding map reading as a starting point in learning process.

We realized that we focus on the spatial ability especially map reading in this research. For further studies, there is another important aspect of map understanding is that map making. Map making is required not only to obtain the entire map understanding but also solve the problem related to the map in daily life such as draw the route from house to school. Designing the map activities especially map making can be helpful to support the development of spatial ability.

6.3 Discussion

Spatial ability is the ability that can influence the mathematical thinking for students especially for building students' geometric imagination (Clements, 2009). Geometric imagination is an important part of exploring spatial relation of object and experiencing mathematics. Spatial relation among objects can be seen in reading a map and giving the direction. Based on the result, we can see that students' could deal with the basic understanding in reading a map. However, the development of spatial ability since early age is less consideration in mathematics education, therefore, educators need to provide the learning activity that can stimulate and facilitate in increasing spatial ability for students. If we can maintain and develop spatial ability of students since low grade, students will have a good spatial ability and have a basic knowledge in geometry. So, students can deal with the geometric problem in high school. It seems that consideration of spatial ability since early age is fruitful to generate the powerful knowledge in geometry for student.

Another interesting topic discussion is about students' understanding of direction. In the second and third activity, many students can overcome easily to distinguish the left side and right side. In contrast, in the fourth activity, many student face difficulty in classifying the position of object whether it is on the left or right side. It is caused by the point of view from the moving objects in the fourth activity. Students still struggle to keep the point of view. Therefore, the notion of point of view should be grasped comprehensively.

In the general results are consistent with an analysis of map reading as divisible into some component (Clarke, 2003): (1) the ability of recognition through searching, location and identifying), (2) orient map by giving the direction, (3) recall from memory to generate different possible ways, and (4) inferential comprehension in reading a map.

REFERENCE

- Clarke, D. (2003). Are you functionally map literate? In Cartographic renaissance: *Proceedings of the 21st International Cartographic Conference*. Durban, South Africa: International Cartographic Association
- Clements, D.H. & Julie Sarama. (2009). *Learning and teaching early math: The learning trajectories approach*. New York: Routledge.
- Depdiknas.(2006). Kurikulum Tingkat Satuan Pendidikan Sekolah Dasar. Jakarta: Depdiknas
- Dickson, L., et.al. (1984). Children learning mathematics.Oxford:Holt, Rinehart and Winston Ltd.
- Diezmann, C. M., &Lowrie, T. (2008). <u>Assessing primary children' knowledge of maps.</u> In O. Figueras, J. L. Cortina, S. Alatorre, T. Rojano& A. Sepúlveda, (Eds.), *Proceedings of the Joint Meeting of the International Group for the Psychology of Mathematics Education 32, and the North American chapter XXX* (Vol. 2, pp. 415-421). Morealia, Michoacán, México: PME.
- Grattoni, C. (2007). Spatial skills and mathematical problem solving ability on high school students.Northwetern University.
- Graveimejer, K.P.E. (1990). Realistic geometrivinstruction.In K.P.E. Gravemeijer, M.Van de Heuvel&I.Streefland (Eds.), Contexts free productions test and geometry in realistic mathematics education (pp. 79-91). Utrecht, The Netherlands: OW&OC.
- Graveimejer, K.P.E. (1994). Developing realistic mathematics education. Utrecht: Cdβ Press.
- Hegarty, M., &Kozhevnikov M. (1999). Types of visual-spatial representation and mathematical problem solving. *Journal of educational Physchology 1999* Vol.91. No 4, 684-689.
- Liben, L. (2008). Understanding maps: Is the purple country on the map really purple?. Knowledge Quest, 36, 20-30.
- Linn, M.C. & Petersen, A.C. (1985). Emergence and Characterization of Sex Difference in Spatial Ability: A Meta Analysis. *Child Development*, 56, 1479-1498.
- Lohman, et al. (1987). Individual differences in spatial abilities, in S. H. Irvine & S. E. Newstead, (Eds.) Intelligence and Cognition, Dordrich: Kluwer.
- Lowrie, T. (2010). Primary Students decoding mathematics task: The role of spatial reasoning. *Research Conference 2010*, 31-34.
- Mackinlay, J. (1999). Automating the design of graphical presentations of relational information In S. K. Card, J. D. Mackinlay, and B. Schneiderman (Eds.), *Readings in information visualization: Using vision to think* (pp. 66–81). San Francisco: Morgan Kaufmann

- Mariana, N. (2010). Birthday cake activity structured arrangementfor helping children determining quantities. *IndoMS. JME*. Vol.1 No.1 Juli 2010, pp.53-70.
- Muehrcke, P. C. (1978). Map use: Reading, analysis and interpretation. Madison, WI: J. P. Publications.
- National Research Council. (2006). Learning to think spatially: GIS as a support system in the K—12 curriculum. Washington, DC: National Academy Press.
- Lawrence, M. M. (2005). The neural basis of map comprehension and spatial abilities. A thesis presented to the Department of Geography. University of Oregon.
- Newcombe, N.S. (2010). Increasing math and science learning by improving spatial thinking. American educator.
- Piaget, J., Inhelder, B. (1967). The child's conception of space. New York, NY: Norton.
- Revina, S. et al. (2011). Spatial visualization task to support students spatial structuring in learning volume measurement.
- Sobel, D. (1998). Mapmaking with children: Sense of place education for the elementary years. Heineman.
- Wiegand, P. (2006). Learning and teaching with maps. New York: Routledge.
- Zulkardi (2002). Developing a 'rich' learning environment on RME for student teachers in Indonesia. *International Journal of the Indonesian Mathematics Society*, January 2003.

APPENDIX 1

A list of topics for classroom observation (before the experiment)

- 1. Practical setting
 - a. How many students are there (Boys and girls)?
 - b. How does the arrangement of classroom setting, for example the arrangement of desk?
 - c. What kind of instructional media that can be used to facilitate teaching and learning process?
 - d. Does the teacher use worksheet or textbook in the teaching and learning process?
 - e. What is the textbook that is used in the class?
- 2. Students' activity
 - a. How do students work individually?
 - b. How do students work in the group?
 - c. How do students response to the teacher whether they are active or passive?
 - d. How do students involve in the discussion both group or classroom discussion?
- 3. Teacher's role
 - a. How do teacher present the material of teaching?
 - b. How do teacher lead discussion, for example invite students to involve in the discussion?
 - c. The way teacher asks the question.
 - d. How do teacher react to the question, opinion, or comment from the students?
- 4. Teaching and learning process
 - a. How the teaching and learning process is started
 - b. What is the approach used during the teaching and learning process
 - c. How is the situation of classroom discussion
 - d. How the teaching and learning process is ended
- 5. Social norm
 - a. How do students explain their strategy?
 - b. How do students challenge other' thinking and justify their own interpretation?
- 6. Sociomathematical norms
 - a. Are there any mathematical different strategies of students' understanding?
 - b. How the teacher initiates the interactive constitution of mathematical difference
 - c. How students acceptable mathematical explanation and justification.

APPENDIX 2

A list of topics for interview with the teacher

- 1. Background of the teacher
 - a. What is your philosophy of mathematics education?
 - b. How long do you become a teacher?
 - c. Why do you interested in education?
 - d. What is your knowledge and experience in mathematics education?
- 2. Planning skills
 - a. What are the contents of your daily lesson plan?
 - b. How you consider the content of lesson plan?
 - c. How do you follow your plan?
 - d. Describe a time when a lesson was not going well?
- 3. Instructional skill
 - a. What is the most effective technique, strategy, or method in your teaching?
 - b. How do you include cooperative learning in your classroom?
 - c. What methods do you use to assess students learning?
 - d. Is drill and practice important? How and when do you use it?
 - e. How do you build the classroom discussion?
 - f. How often do you use the supporting material in teaching process?
 - g. How do you establish socio-mathematical norms?
- 4. Classroom management
 - a. How do you manage your class? Is there a specific rule in your class?
 - b. How do you deal with the unmotivated students?
 - c. How do you handle to keep students actively during a lesson?
 - d. How do you create a safe atmosphere in your classroom?
- 5. Knowledge of content (The topic of the study and RME/PMRI)
 - a. What do you know about PMRI?
 - b. Have you joined the PMRI's workshop? If yes, can you describe your experience during the workshop?
 - c. How do you make a connection with the mathematical concepts and daily life in your practice?
 - d. What do you know about map skills in mathematics?
 - e. How did you teach this topic in previous?
 - f. What is the material that proper for this topic?
 - g. What is the difficulty to teach this topic based on your experience?

APPENDIX 3

Rencana Pelaksanaan Pembelajaran

(RPP)

Madrasah	: MIN 2 Model Palembang
Mata Pelajaran	: Matematika
Kelas/Semester	: II/Genap
Pertemuan	: 1 (Pertama)
Alokasi Waktu	: 2 x 35 menit
Standar Kompetensi	: 4. Mengenal unsur-unsur bangun datar sederhana (Pengayaan)

A. Tujuan Pembelajaran

• Siswa memahami peta madrasahnya

:

- Siswa dapat memahami posisi antara suatu ruangan dengan ruangan lainnya berdasarkan informasi di peta madrasah.
- Siswa dapat membaca dan menggunakan peta madrasahnya dalam memecahkan suatu masalah yang berkaitan dengan lokasi suatu tempat di madrasahnya.

B. Indikator :

- Siswa dapat membaca peta madrasahnya
- Siswa dapat menjelaskan posisi ruangan di peta madrasah.
- Siswa dapat menyebutkan informasi yang di dapat dari peta.
- Siswa dapat menggunakan peta madrasah untuk memecahkan suatu masalah.

C. Materi Pembelajaran

Peta merupakan salah satu bentuk atau contoh dari bentuk grafis yang menggambarkan posisi dan lokasi dari suatu objek dengan skala pengecilan tertentu (Mackinlay, 1999). Sesuai dengan definisi dari spasial yang berkaitan erat dengan posisi dan lokasi dari suatu objek, maka peta dapat digunakan sebagai suatu alat dan sarana untuk mengembangkan kemampuan berpikir spasial anak (Clarke, 2003).

Pada pembelajaran ini, guru dapat mengenalkan lokasi madrasah dengan menggunakan peta madrasah serta melibatkan suatu masalah yang berkaitan dengan peta madrasah.



Gambar 1. Peta madrasah

Siswa diharapkan menggunakan kemampuan awalnya untuk membaca peta madrasah ini sebagai salah satu pengalaman belajar yang melibatkan peta. . Dengan memberikan pengalaman kepada siswa untuk dapat memecahkan masalah, siswa dapat merasakan pembelajaran yang lebih bermakna baginya.

D. Pendekatan Pembelajaran

Pendekatan PMRI (Pendidikan Matematika Realistik Indonesia)

E. Kegiatan Pembelajaran

Kegiatan	Uraian	Waktu
Kegiatan Awal	 Berdoa Apersepsi Siswa ditanya tentang pengetahuan awalnya mengenai lokasi suatu ruangan di lingkungan madrasah, misalnya ruangan UKS. Guru memotivasi siswa dengan menyampaikan kegiatan yang akan dilakukan oleh siswa. Guru: Anak-anak pada pembelajaran kali ini, kalian akan berperan sebagai detektif yang mempunyai misi untuk mengumpulkan bintang-bintang yang tersebar di madrasah. Untuk mengetahui posisi bintang tersebut, kalian akan diberikan sebuah peta yang menunjukkan lokasi dari bintang-bintang. Siswa diberikan pre test selama 15 menit 	20 menit
Kegiatan Inti	1. Siswa diperkenalkan tentang peta madrasahnya .	40 menit



	7. Siswa dibimbing oleh guru untuk berdiskusi kelas.	
	Beberapa topik diskusi yaitu:	
	a. Guru: Bagaimana kalian memahami informasi yang	
	terdapat di peta madrasah?	
	Siswa 1: Membaca nama-nama ruangannya.	
	Siswa 2 : Mengenal posisi/lokasi ruangan di madrasah.	
	Siswa 3: Mengetahui lokasi bintang.	
	b. Guru : Lalu, Apakah kalian mudah untuk menemukan	
	bintang?	
	Siswa 1 : Mudah, bu	
	Guru : Mengapa?	
	Siswa 1: Karena ada petunjuk posisi bintang di peta	
	Siswa 2 : Susah, bu menemukan bintangnya	
	Guru : Mengapa:	
	Siswa 2 : Karena tidak tahu posisi bintang (tidak	
	memahami lokasi objek di peta)	
	c. Guru: Bagaimana kalian menemukan bintang?	
	Siswa 1 : Dengan mengikuti petunjuk di peta	
	Siswa 2 : Dengan melihat ruangan yang dekat dengan	
	gambar bintang.	
	d. Guru : Ruangan apa saja yang dilalui oleh kalian	
	saat mengumpulkan bintang pertama?	
	Siswa : Kantin, taman, wc (sesuai dengan pengalaman	
	siswa)	
Kegiatan akhir	Siswa dan guru melakukan refleksi nembelaiaran	10 menit
itegiatan akim	dengan memberikan beberapa pertanyaan seperti	10 mont
	Ana vang kita pelajari hari ini?	
	 Hal penting ana saja yang kita pelajari? 	
	Dagaimana atratagimu dalam membaga rata	
	 Bagaimana strateginu dalam membaca peta 	

untuk menemukan jalan/rute?	

F. Media Pembelajaran

- Peta Madrasah
- Kertas berwarna berbentuk bintang

G.Penilaian

Bentuk test : Pre-test

Bentuk soal : Tertulis isian

Indikator dan soal

Indikator	Soal						
1.Siswa dapat	1.Dimanakah posisi gambar berikut berdasarkan peta sebelumnya?						
mengingat posisi	(Lingkarilah jawabanmu)						
lokasi suatu objek	1.						
	A B C D E $A B C D E$ $A B C D E$ $B B$ $E C D E$ $B C D E$ $A B C D E$ $B C D E$ $B C D E$ $C C D E$						
2. Siswa dapat memahami orientasi dengan membedakan gambar tangan kanan dan kiri	2.Gambar tangan apalah di bawah ini, gambar tangan kanan atau kiri Beri tanda silang pada kotak kanan untuk tangan kanan Beri tanda silang pada kotak kiri untuk tangan kiri X						



Rubrik Penilaian

No	Kunci jawaban	Skor
1.	1. A	1
	2. C	1
	3. B	1
2.	X X X X	1 1 1
	x X x	1 1 1
3.	1.C	1
	2. P	1
	3. A	1
	4. P	1
	Jawaban salah	0
	Total skor	13

Nilai = _____ × 100

Kepala MIN 2 Model Palembang

Budiman, S.Pd, MM.Pd

NIP. 196709012000031002

Palembang, 13 Maret 2013 Mengetahui Guru kelas II

R.A.Mustika Hariyanti, S.Pd NIP. 198301122005012004

Peneliti

Elika Kurniadi, S.Pd NIM.20112812002

Material



Pre Test

Test ini dikerjakan dalam waktu 20 menit

1. Siswa melihat gambar di bawah ini dalam waktu 10 detik.



1. Dimanakah posisi gambar berikut berdasarkan peta sebelumnya? (Lingkarilah jawabanmu)



2. Gambar tangan apalah di bawah ini, gambar tangan kanan atau kiri Beri tanda silang pada kotak kan<u>an untuk tang</u>an kanan

Beri tanda silang pada kotak kiri untuk tangan kiri



Х



- B bergerak ke kiri 1 langkah. Dimanakah B sekarang? Jawabana:
- 2. O bergerak ke kanan 1 langkah. Dimanakah O sekarang? Jawaban:
- 3. J bergeraka 2 langkah ke depan dan 1 langkah kek kiri. Dimanakah J sekarang? Jawaban:
- 4. G bergerak 1 langkah ke kanan dan 2 langkah ke belakang. Dimanakah G sekarang? Jawaban :

Rencana Pelaksanaan Pembelajaran

(RPP)

Madrasah	: MIN 2 Model Palembang
Mata Pelajaran	: Matematika
Kelas/Semester	: II/Genap
Pertemuan	: 2 (Kedua)
Alokasi Waktu	: 2 x 35 menit
Standar Kompetensi	: 4. Mengenal unsur-unsur bangun datar sederhana (Pengayaan)

A. Tujuan Pembelajaran

- Siswa memahami terminologi orientasi, seperti kanan, kiri, maju dan mundur.
- Siswa mampu membedakan antara kanan dan kiri.

:

• Siswa dapat menemukan posisi dari suatu objek tertentu dengan menggunakan terminology orientasi

B. Indikator :

- Siswa dapat menyebutkan posisi benda berdasarkan kanan, kiri, depan, atau belakang.
- Siswa dapat menjelaskan perbedaan kanan dan kiri.
- Siswa dapat menemukan posisi suatu objek..
- Siswa dapat menggunakan terminologi orientasi.

C. Materi Pembelajaran

Visual persepsi adalah proses dalam pengorganisasian dan intepretasi dari informasi yang diterima secara visual. Salah satu bentuk dari visual persepsi adalah visual spasial. Visual spasial yaitu kemampuan untuk membedakan lokasi posisi dari suatu objek seperti kanan, kiri, atas dan bawah. Kemampuan dasar ini diperlukan untuk melatih kemampuan membaca peta/denah dari suatu tempat.

Dalam bidang matematika, pemahaman awal mengenai orientasi arah dapat digunakan sebagai landasan untuk memahami bentuk grafis seperti peta, garis bilangan, diagram kartesius dan sebagainya.
MEMBACA ARAH PADA PETA



D. Pendekatan Pembelajaran

Pendekatan PMRI (Pendidikan Matematika Realistik Indonesia)

E. Kegiatan Pembelajaran

Kegiatan	Uraian	Waktu
Kegiatan	- Berdoa	10 menit
Awal	Apersepsi	
	- Guru menanyakan pengetahuan awal siswa tentang terminologi	
	orientasi:	
	a. Guru: Pernahkan kalian mendengar petunjuk seperti belok ke	
	kanan, ke kiri, maju ataupun mundur? Dan pada saat kapan?	
	Siswa 1 : Pernah saat di tempat parkir	
	Siswa 2 : Pernah saat berbaris untuk upacara bendera	
	Siswa 3 : Pernah saat naik motor/mobil di jalan.	
	b. Guru: Dapatkah kalian memberikan contoh kalimat petunjuk arah	
	tertentu?, misalnya meja bu guru di sebelah kanan	
	Siswa 1 : Pintu berada di sebelah kiri.	
	Siswa 2 : Papan tulis ada di depan.	
	Siswa 3 : Saya makan menggunakan tangan kanan.	

	c. Guru : Siapakah siswa yang duduk di sebelah siswa A?	
	Siswa 1 : Siswa B (jawaban benar)	
	Siswa 2 : Siswa C (jawaban salah)	
	-Guru memotivasi siswa dengan menyampaikan kegiatan yang akan dilakukan oleh siswa. Guru: Anak-anak pada pembelajaran kali ini, kalian akan mempelajari tentang apa itu kanan? Dan apa itu kiri? Atau maju, mudur, depan dan belakang. Jadi, nanti kalian dapat menggunakan kata-kata itu untuk menunjukkan lokasi suatu benda dalam kehidupan sehari-hari.	
Kegiatan	Kegiatan 1: Menggerakkan badan	55 menit
Inti	1. Siswa diberi beberapa petunjuk arah untuk menggerakkan	
	badannya ke kanan, kiri, maju ataupun mundur beberapa langkah,	
	contohnya:	
	a. Hadap ke kanan	
	b. Hadap ke kiri	
	c. Maju 3 langkah	
	d. Mundur 2 langkah	
	2. Setelah siswa mendapatkan pengalaman menggerakkan badannya	
	sesuai dengan instruksi yang diberikan guru, lalu guru melakukan	
	diskusi kelas tentang:	
	a. Guru : Mengapa beberapa siswa tidak dapat membedakan antara	
	kanan dan kiri?	
	Siswa 1 : Tidak tahu kanan dan kiri	
	Siswa 2 : Tidak bisa membedakan kanan dan kiri	
	b.Guru : Bagaimana siswa dapat membedakan antara kanan dan kiri?	
	Siswa 1: Tangan kanan untuk makan	
	Siswa 2 : Tangan kiri memakai jam tangan	
	Siswa 3 : Menulis menggunakan tangan kanan	
	c. Guru : Dapatkah kalian mengungkapkan caramu membedakan kanan dan kiri?	

Siswa 1 : Mengingat tangan makan

Siswa 2 : Mengingat tangan menulis

Siswa 3 : Mengingat 1 tangan kanan/kiri

Kegiatan 2 : Denah Kelas

1. Guru menjelaskan masalah kepada siswa

Guru :Anak-anak ibu butuh bantuan kalian untuk membuat denah kelas. Denah kelas tersebut akan digunakan untuk mengetahui posisi tempat duduk siswa di kelas.



2. Setelah menyelesaikan tugas mengisi nama-nama siswa di denah kelas, guru meminta siswa untuk menjawab beberapa pertanyaan yang berkaitan dengan posisi tempat duduk siswa di denah kelas tersebut, seperti:

- a. Siapakah yang duduk di sebelah kanan A?
- b. Siapakah yang duduk di sebelah kiri B?
- c. Siapakah yang duduk di belakang C?
- d. Siapakah yang duduk di depan D?
- e. Siapakah siswa yang duduk 2 langkah di sebelah kiri siswa E?
- f. Siapakah siswa yang duduk 3 langkah di sebelah kiri siswa F?
- g. Siapakah siswa yang duduk 2 langkah di depan siswa G?
- h. Siapakah siswa yang duduk 3 langkah di belakang siswa H?
- *i.* Siapakah siswa yang duduk 3 langkah di kiri lalu 2 langkak ke depan dari siswa I?

	j. Siapakah siswa yang duduk 1 langkah di belakang lalu 3					
	langkak ke kanan dari siswa J?					
	3. Siswa diminta untuk menjawab pertanyaan tersebut di kertas A4					
	soal yang dibacakan.					
	4.Guru dapat mendiskusikan di kelas apakah jawaban siswa tersebut					
	benar ataupun salah tentang bagaimana siswa menjawab pertanyaan					
	tersebut secara benar ataupun kesalahan yang dilakukan siswa dalam					
	menjawab pertanyaan.					
Kegiatan	Siswa dan guru melakukan refleksi pembelajaran dengan					
akhir	memberikan beberapa pertanyaan seperti:					
	• Apa saja yang kita pelajari hari ini?					
	• Hal penting apa yang dipelajari tentang memahami					
	kata-kata petunjuk seperti kiri, kanan, maju, dan					
	mundur?					
	Bagaimana strategimu untuk membedakan sisi kanan					
	dan kiri?					

F. Media Pembelajaran

- Denah kelas
- Kertas A4

G.Penilaian

Bentuk test : Penilaian aktivitas

Bentuk penilaian: Observasi

Rubrik pengamatan

Kriteria pengamatan	Ya	Tidak
Kegiatan 1:		
1.Siswa menggerakkan badan sesuai dengan petunjuk		
guru		
2.Siswa menggerakkan badan dengan benar sesuai		
dengan petunjuk guru		

3. Siswa memperhatikan petunjuk arahan dari guru	
4. Siswa mengemukakan caranya membedakan kanan	
dan kiri	
Kegiatan 2	
1.Siswa mengisi nama-nama siswa di denah kelas yang	
telah disediakan.	
2. Siswa menjawab pertanyaan guru di kertas A4	
3. Siswa menjawab pertanyaan guru dengan benar	
4. Siswa mengungkapkan strateginya untuk menjawab	
pertanyaan tentang posisi tempat duduk dari denah kelas	

Palembang, 13 Maret 2013

Mengetahui

Guru kelas II

Kepala MIN 2 Model Palembang

Budiman, S.Pd, MM.Pd

NIP. 196709012000031002

R.A.Mustika Hariyanti, S.Pd

NIP. 198301122005012004

Peneliti

Elika Kurniadi, S.Pd

NIM.20112812002

Material

1.Denah kelas 9 Lihatlah posisi teman-temanmu!!!! Nama :1..... 2..... Denah Kelas II.A Papan Tulis Lemari Pintu Meja Guru

Rencana Pelaksanaan Pembelajaran

(RPP)

Madrasah	: MIN 2 Model Palembang
Mata Pelajaran	: Matematika
Kelas/Semester	: II/Genap
Pertemuan	: 3 (Ketiga)
Alokasi Waktu	: 2 x 35 menit
Standar Kompetensi	: 4. Mengenal unsur-unsur bangun datar sederhana (Pengayaan)

A. Tujuan Pembelajaran

- Siswa mendapatkan pemahaman dalam mengikuti petunjuk arah yang diberikan.
- Siswa mempelajari tentang navigasi dalam bentuk sederhana.

B. Indikator :

- Siswa mengikuti petunjuk arah yang diberikan.
- Siswa menemukan pentingnya arah acuan dalam navigasi

C. Materi Pembelajaran

Komponen petunjuk arah sering juga disebut dengan mata angin, dan orientasi.

Petunjuk arah sebagai salah satu komponen kelengkapan pada peta merupakan komponen yang harus ada dalam sebuah peta. Sesuai dengan namanya, fungsi penunjuk arah memberikan informasi arah utara, timur, selatan, barat dan atau arah daerah yang digambar.



Penempatan komponen petunjuk arah dapat ditempatkan bebas, tetapi biasanya ditempatkan di bagian atas peta utama. Informasi arah tidak harus ditampilkan seluruhnya, bisa hanya satu arah saja misalnya arah utara.



Desain/bentuk petunjuk arah dapat digambar secara bebas, hal ini merupakan kebebasan dari pembuat peta. Beberapa contoh petunjuk arah yang biasa kita temui misalnya sebagai berikut.



Dalam pembelajaran ini, petunjuk arah sebagai titik acuan sangat penting ditekankan bagi siswa untuk dapat memecahkan permasalahan tentang navigasi sederhana dalam mengikuti

instruksi arah yang diberikan. D. Pendekatan Pembelajaran

Pendekatan PMRI (Pendidikan Matematika Realistik Indonesia)

E. Kegiatan Pembelajaran

Kegiatan	Uraian	Waktu
Kegiatan	- Berdoa	5
Awal	Apersepsi	menit
	- Siswa ditanya tentang kegiatan pembelajaran yang lalu mengenai perbedaan	
	kanan dan kiri.	
	-Guru memotivasi siswa dengan menyampaikan kegiatan yang akan dilakukan oleh	
	siswa.	
	Guru: Anak-anak pada pembelajaran kali ini, kalian akan mempelajari tentang	
	sistem navigasi yang sederhana. Apakah kalian pernah mendengar kata 'navigasi'	
	sebelumnya? Navigasi diperlukan oleh asisten pilot untuk membantu pilot	
	menjalankan pesawat dengan memberikan arahan yang benar sehingga pesawat	
	sampai ke tujuan.	



	5. Siswa diminta untuk untuk menunjukkan hasil kerjanya di depan kelas dan					
	meminta siswa lainnya melihat hasil jawaban temannya serta mencari perbedaan					
	antara satu dan yang lainnya. 6. Lalu, guru dapat menciptakan diskusi kelas:					
	a. Guru : Adakah perbedaan antara satu denah dan yang lainnya?					
	Siswa 1 : Ada yang menempelkan nama ruangan yang tidak pada tempatnya.					
	(misalnya, posisi ruangan santai ditulis dengan ruang belajar).					
	h. Guru : Perhedaan seperti apakah itu?					
	Siswa : Perbedaan menempelkan nama ruangan					
	c. Guru : Mengapa bisa berbeda?					
	Siswa 1: Karena tidak mengikuti petunjuk guru dan tidak fokus.					
	Siswa 2 : Karena keliru dalam membedakan kanan dan kiri					
	Siswa 3 : Karena salah melihat arah depan (arah acuan).					
	d. Guru : Bagaimana strategimu untuk mengikuti petunjuk arah yang diberikan?					
	Siswa : melihat arah acuan /menghadap ke arah depan (memiliki 1 titik fokus/orientasi).					
	7. Dan, Siswa dapat ditanya tentang kemungkinan untuk terjadinya jawaban seperti					
	berikut ini: (ruangan santai berada di sebelah kiri ruang tamu):					
	Ruang Ruang Ruang					
	santai tamu santai					
	Siswa 1 : Tidak mungkin, karena kanan dan kiri berbeda. (Ruang santai berada di					
	sebelah kiri ruang tamu).					
	Siswa 2 : Mungkin, karena jika menghadap depan maka ruang santai di kiri, tetapi					
	jika berjalan mundur/menghadap belakang maka ruang santai terlihat di sebelah					
	kanan dari arah depan (menentukan arah acuan sangat penting).					
Kegiatan	Siswa dan guru melakukan refleksi pembelajaran dengan memberikan beberapa	10				
akhir	pertanyaan seperti:	menit				
	• Apa yang kita pelajari hari ini?					
	• Apa yang penting dalam mengikuti petunjuk arah?					

F. Media Pembelajaran

- Denah ruangan istana
- Kertas tempel ruangan istana.

G.Penilaian

Bentuk test : Penilaian diskusi

Bentuk penilaian: Observasi

Lembar observasi

No.	Nama	Aspe	k yan	g dinil	lai			Skor/jumlah
		1	2	3	4	5	6	

Aspek yang dinilai:

- 1. Kemampuan menyampaikan pendapat
- 2. Kemampuan mempertahankan argumentasi
- 3. Kemampuan bertanya
- 4. Kemampuan memberikan kritik
- 5. Kemampuan menggunakan bahasa yang baik dan benar
- 6. Kelancaran dalam berbicara

Nilai skor:

Jumlah skor

1 = Tidak baik	6 - 11 = Kurang
2 = Kurang baik	12 – 17 = Cukup
3 = Cukup baik	18 – 23 = Baik
4 = Baik	24 - 30 = Sangat baik

5 = Sangat Baik

Palembang, 13 Maret 2013 Mengetahui Guru kelas II

Kepala MIN 2 Model Palembang

Budiman, S.Pd, MM.Pd

NIP. 196709012000031002

R.A.Mustika Hariyanti, S.Pd NIP. 198301122005012004

Peneliti

Elika Kurniadi, S.Pd NIM.20112812002 Material

Nama	: 1	
	2	
Kelas	:	





Rencana Pelaksanaan Pembelajaran

(RPP)

Madrasah	: MIN 2 Model Palembang
Mata Pelajaran	: Matematika
Kelas/Semester	: II/Genap
Pertemuan	: 4 (Keempat)
Alokasi Waktu	: 2 x 35 menit
Standar Kompetensi	: 4. Mengenal unsur-unsur bangun datar sederhana (Pengayaan)

A. Tujuan Pembelajaran

- Siswa mendapatkan pemahaman yang lebih untuk mengidentifikasi objek.
- Siswa membuat sebuah rute perjalanan yang sederhana.

:

B. Indikator :

- Siswa dapat mengidentifikasi objek.
- Siswa dapat menyebutkan objek yang ditemui
- Siswa dapat menggambar rute perjalanan yang sederhana.

C. Materi Pembelajaran:

Permainan puzzle merupakan salah satu permainan yang dapat idgunakan untuk melatih kemampuan visual spasial. Kemampuan visual spasial merupakan kemampuan untuk memahami bentuk, gambar, warna, dan sebagainya. Kesadaaran spasial termasuk orientasi tubuh terhadap objek benda lain dalam suatu ruang dan melihat hubungan antar objek satu dan yang lainnya.

Anak-anak yang mempunyai kemampuan spasial yang baik bisa menyelesaikan masalah/permaianan yang berkaitan dengan membuat peta, membaca peta untuk menemukan jalan, atau menyelesaikan puzzle.

Salah satu contoh puzzle:



Selain itu, puzzle di atas memberikan kesempatan kepada siswa untuk menggambarkan rute perjalanan sederhana yang dilalui kura-kura dari titik start menuju garis finish.

D. Pendekatan Pembelajaran

Pendekatan PMRI (Pendidikan Matematika Realistik Indonesia)

E. Kegiatan Pembelajaran

Kegiatan	Uraian	Waktu
Kegiatan	- Berdoa	10
Awal	Apersepsi	menit
	- Siswa ditanya tentang pelajaran yang lalu mengenai sistem navigasi sederhana	
	dalam mengikuti petunjuk arah yang diberikan.	
	-Guru memotivasi siswa dengan menyampaikan kegiatan yang akan dilakukan	
	oleh siswa.	
	Guru: Anaak-anak hari ini kita akan belajar tentang hewan-hewan yang ada di	
	bawah laut. Jadi, hewan laut apa saja yang pernah kalian liat atau dengar?	
	Siswa memberikan respon dengan menjawab sesuai dengan pengetahuan dan	
	pengalaman yang mereka punya.	
Kegiatan	1.Guru menjelaskan permasalahan:	50
Inti	Problem pertama: Hewan laut apa saja yang terdapat di puzzle ini?Untuk bisa	menit
	menjawab pertanyaan tersebut, maka kalian harus bisa menyusun puzzle berikut!	



Guru : Bagaimana siswa mengidentifikasi potongan puzzle yang satu dan yang lainnya?

Siswa : Dengan melihat gambar yang terpotong dan mencari gambar yang memiliki potongan serupa, sehingga membentuk gambar yang utuh.

4. Selanjutnya, guru menceritakan tentang cerita kura-kura di puzzle. Cerita : Seekor kura-kura ingin bertemu dengan temannya. Jalan manakah yang harus ditempuh oleh si kura-kura.?

Problem yang kedua: Dapatkah kalian membantu si kura-kura menemukan jalan untuk menemui temannya? Selain itu, siswa harus menggambarkan garis



F. Media Pembelajaran

- Puzzle
- Lembar jawaban siswa

G.Penilaian

Bentuk test : Penilaian diskusi

Bentuk penilaian: Observasi

Lembar observasi

No.	Nama	Aspek yang dinilai				Skor/jumlah		
		1	2	3	4	5	6	

Aspek yang dinilai:

- 1. Kemampuan menyampaikan pendapat
- 2. Kemampuan mempertahankan argumentasi
- 3. Kemampuan bertanya
- 4. Kemampuan memberikan kritik
- 5. Kemampuan menggunakan bahasa yang baik dan benar
- 6. Kelancaran dalam berbicara

Nilai skor:

1 = Tidak baik	6 – 11 = Kurang
2 = Kurang baik	12 – 17 = Cukup
3 = Cukup baik	18 – 23 = Baik
4 = Baik	24 – 30 = Sangat baik
5 = Sangat Baik	

Palembang, 13 Maret 2013

Mengetahui

Kepala MIN 2 Model Palembang

Budiman, S.Pd, MM.Pd

NIP. 196709012000031002

Guru kelas II

Jumlah skor

R.A.Mustika Hariyanti, S.Pd NIP. 198301122005012004

Peneliti

Elika Kurniadi, S.Pd NIM.20112812002

Material

	Nama : 1 2 Tanggal :
Ayo, bantu kura-kura menemukan jalan ! Kura-kura	Kuda laut Ikan Paus Gurita Ikan hias Ikan zebra Ikan hias Ikan zebra Ikan badut Gurita Ikan badut

 Gambarlah garis perjalanan kura-kura menemui temannya ! Tulislah nama hewan yang ditemui kura-kura sesuai dengan posisi hewan tersebut!

2. Isilah nama-nama hewan tabel berikut berdasarkan posisi hewan yang ditemui kura-kura!

Di sebelah kiri kura-kura	Di sebelah kanan kura-kura

Rencana Pelaksanaan Pembelajaran

(RPP)

Madrasah	: MIN 2 Model Palembang
Mata Pelajaran	: Matematika
Kelas/Semester	: II/Genap
Pertemuan	: 5 (Kelima)
Alokasi Waktu	: 2 x 35 menit
Standar Kompetensi	: 4. Mengenal unsur-unsur bangun datar sederhana (Pengayaan)

A. Tujuan Pembelajaran

• Siswa dapat memahami peta lokasi pada umumnya

:

• Siswa dapat menyelesaikan masalah yang berkaitan dengan peta lokasi

B. Indikator :

- Siswa dapat membaca peta lingkungan sekitarnya
- Siswa dapat menyebutkan objek yang terdapat di peta lokasi.
- Siswa dapat menemukan rute perjalanan yang akan ditempuh
- Siswa dapat menemukan beberapa kemungkinan rute perjalanan
- Siswa dapat menemukan rute perjalanan terpendek.
- Siswa dapat menggambar rute perjalanan.

C. Materi Pembelajaran

Peta merupakan salah satu bentuk atau contoh dari bentuk grafis yang menggambarkan posisi dan lokasi dari suatu objek dengan skala pengecilan tertentu (Mackinlay, 1999). Sesuai dengan definisi dari spasial yang berkaitan erat dengan posisi dan lokasi dari suatu objek, maka peta dapat digunakan sebagai suatu alat dan sarana untuk mengembangkan kemampuan berpikir spasial anak (Clarke, 2003).

Pada pembelajaran ini, guru dapat mengenalkan lokasi peta Palembang. Peta lokasi adalah suatu peta lokasi yang lazim dan mudah ditemukan dalam kehidupan sehari-hari, misalnya di

kartu undangan. Dengan melakukan aktivitas pembelajaran tentang peta lokasi, maka siswa akan terbiasa dengan bentuk-bentuk represntasi dalam matematika misalnya peta.

Dalam matematika, beberapa pertanyaan matematika yang sering muncul dalam permasalahan yang berkaitan dengan peta yaitu : Benda apa (berkaitan dengan kemampuan mengidentifikasi objek-objek yang terdapat dalam peta), Dimana (berkaitan dengan lokasi objek suatu benda), dan Jalan yang mana (berkaitan dengan kemungkinan jalan-jalan yang bisa detempuh ataupun memilih rute jalan terpendek)

D. Pendekatan Pembelajaran

Pendekatan PMRI (Pendidikan Matematika Realistik Indonesia)

E. Kegiatan Pembelajaran

Kegiatan	Uraian	Waktu
Kegiatan Awal	- Berdoa	5 menit
	Apersepsi	
	- Siswa ditanya tentang pengalaman atau pengetanuan	
	mungkin pernah melihat peta lokasi yang tertera di	
	undangan pernikahan.	
Kegiatan Inti	1. Siswa diberi kertas lokasi kota Palembang	45 menit
	2. Siswa diminta menjelaskan informasi yang	
	didapatkan di peta lokasi yang diberikan:	
	Siswa 1 : Terdapat nama jalan, gedung, dan tempat di	
	peta lokasi	
	Siswa 2 : Kita bisa menemukan jalan untuk ke suatu	
	tempat	
	Siswa 3 : Kita dapat menentukan rute terpendek dari	
	peta lokasi.	
	3. Siswa diberikan 4 permasalahan soal yang berkaitan	
	dengan peta lokasi.	
	4. Siswa mengerjakan dan berdiskusi tentang soal-soal	
	tersebut dengan teman sebangkunya selama 20 menit.	
	5. Guru berkeliling kelas untuk memberikan bantuan	
	atau penjelasan mengenai soal jika ada siswa yang	
	belum paham.	

Kegiatan akhir	Siswa dan guru melakukan refleksi pembelajaran	10 menit
	dengan memberikan beberapa pertanyaan seperti:	
	• Apa yang kita pelajari hari ini?	
	• Hal penting apa saja yang kita pelajari?	
	Bagaimana strategimu dalam membaca peta	
	untuk menemukan jalan/rute?	

F. Media Pembelajaran

- Peta Madrasah
- Kertas berwarna berbentuk bintang

G.Penilaian

Bentuk test : Pre-test

Bentuk soal : Tertulis isian

Indikator dan soal

Indikator	Soal
1.Siswa dapat mengingat posisi lokasi suatu objek	1.Dimanakah posisi gambar berikut berdasarkan peta sebelumnya? (Lingkarilah jawabanmu)
2. Siswa dapat	2.Gambar tangan apalah di bawah ini, gambar tangan kanan atau kiri
memahami	Beri tanda silang pada kotak kanan untuk tangan kanan
orientasi dengan	
membedakan	
gambar tangan	Beri tanda silang pada kotak kiri untuk tangan kiri



Rubrik Penilaian

No	Kunci jawaban	Skor		
1.	1. B	1		
	2. A	1		
	3. D	1		
	4.F	1		
2.	X X X	1 1 1		
	x X x	1 1 1		
3.	1.Dina	1		
	2.a. Budi	1		
	b. Gambar rute	1		
	3. a. Rendi	1		
	b. Gambar rute	1		
	4. Winda	1		
	Jawaban salah	0		
	Total skor	16		

Nilai = _____ × 100

Mengetahui

Kepala MIN 2 Model Palembang

Palembang, 13 Maret 2013

Guru kelas II

Budiman, S.Pd, MM.Pd

NIP. 196709012000031002

R.A.Mustika Hariyanti, S.Pd NIP. 198301122005012004

Peneliti

Elika Kurniadi, S.Pd NIM.20112812002

Peta Lokasi di Palembang



	121
NAMA	: 1
	2

Diskusikan dengan teman sebangkumu!

TANGGAL:

1. Ibu Elika berjalan sepanjang jalan Basuki Rahmat. Tuliskan objek/gedung apa saja yang dilihat ibu Elika di jalan Basuki Rahmat?

Jawaban :			

2. Ibu Elika sedang berada di kantor Polda. Jika ibu Elika akan pergi menuju airport. Buatlah garis perjalanan ibu Elika dari polda ke airport. (Tulis nama jalan dan objek/gedung sesuai dengan posisinya di sepanjang garis perjalanan yg kalian buat)

Jawaban :

3. Ibu Elika tinggal di perumahan Asri. Jika ibu Elika akan menjenguk temannya yang sakit di RS Hermina, maka ada berapa rute/cara/jalan yang bisa ditempuh oleh ibu Elika?

Jawaban :rute/cara/jalan

Gambarkan garis rute/cara/jalan yang bisa ditempuh (Tulis nama jalan dan objek/gedung sesuai dengan posisinya di sepanjang garis perjalanan yg kalian buat)

4. Dari beberapa garis perjalanan yang kalian buat. Pilihlah satu saja yang merupakan rute/cara/jalan terpendek/ Gambarkan di kotak berikut ini dan Tulis nama jalan dan objek/gedung sesuai dengan posisinya di sepanjang garis perjalanan yg kalian buat

Jawaban :

	NAMA	:							
	KELAS	:							
TANGGAL:									
<									

POST TEST

A. Perhatikan peta berikut ini selama 10 detik.Buka halaman selanjutnya dan halaman ini tidak boleh dilihat kembali.





Lingkarilah jawaban yang benar

Dimanakah posisi tempat berikut!



B. Gambar tangan apalah di bawah ini, gambar tangan kanan atau kiri Beri tanda silang pada kotak kanan untuk tangan kanan

Beri tanda silang pada kotak kiri untuk tangan kiri



х

C.Perhatikan denah kelas berikut!

Denah I	Kelas II.A		PAPAN J	CULIS.			
÷	<u>Meja</u> gur	u A			7		Pint
Ani	Sinta	Tuti	Weni	Anton	Eke	Gina	Eni
Budi	Tene]	Mega	Winda]	Rika	Andi]	Isa]	Lita
Joko	Ridwan	Heni	Indah	Rita	Eani	Arman	Rendi
Susi	Rini]	[Rian]	Dedi]	Yuni	Dina	Sis]	Ridho
	1	Dina 1		Neri	No. 1	This]	

- 1. Siapakah yang duduk di sebelah kanan Yuni?
- 2. Siapakah yang duduk di sebelah kiri Tono ?

3. Jika Neni berjalan 2 langkah ke depan lalu 3 langkah ke kanan. Dimanakah neni sekarang?.....

Buatlah garis perjalanan Neni dan tulislah nama siswa yang ditemui Neni sepanjang garis perjalanan itu?

4. Jika Eko berjalan mundur 1 langkah lalu 2 langkah ke kiri. Dimanakah Eko sekarang?

Buatlah garis perjalanan Eko dan tulislah nama siswa yang ditemui Eko sepanjang garis perjalanan itu