

**USING CARDINAL DIRECTIONS IN MAP READING ACTIVITIES  
TO SUPPORT THE DEVELOPMENT OF STUDENTS' SPATIAL  
ORIENTATION**

**MASTER THESIS**



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**PROGRAM STUDI PENDIDIKAN MATEMATIKA  
PROGRAM PASCASARJANA  
UNIVERSITAS NEGERI SURABAYA  
2015**

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**MASTER THESIS**

**A Thesis submitted to  
Surabaya State University Postgraduate Program  
as a Partial Fulfilment of the Requirement for the Degree of  
Master of Science in Mathematics Education Program**

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**PROGRAM STUDI PENDIDIKAN MATEMATIKA  
PROGRAM PASCASARJANA  
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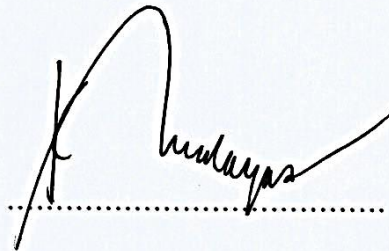
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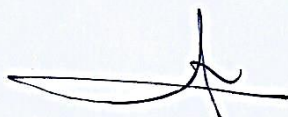
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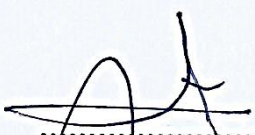
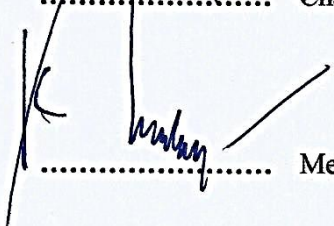
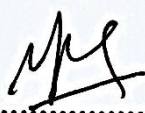
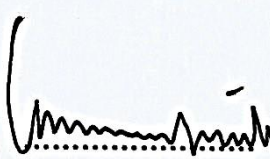
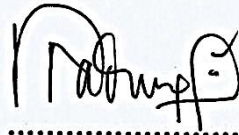
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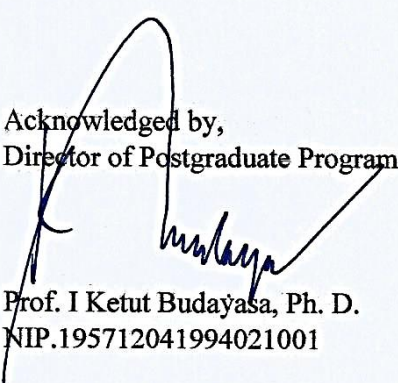
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*Read in the name of your Lord Who created. He created man from a clot. Read and your Lord is Most Honorable, who taught (to write) with the pen. Taught man what he knew not. (Surat Al `alaq, 96:1~5)*

## DEDICATION

*This thesis is dedicated for:*

*My beloved Mama, Sinar, a warm light illuminating my world.*

*My wonderful Bapak, Nursalim Ali. You are my lifetime hero.*

*My grandmother, (Alm) Ibu for all the advices. I am sorry I have not  
given what you want before you go.*

*My beautiful sisters, Irmayanti, S.Pd., Rismawati, S.Pd., and*

*Nurmaharaeni, you are my best friend ever.*

*My lovely nieces and nephew, Uyah, Sofie, and Occhank, my sources of joy  
and happiness*

## ABSTRACT

Ermita. 2015. Using Cardinal Directions in Map Reading Activities Supports the Development of Students' Spatial Orientation. Thesis, Mathematics Education Study Program, Postgraduate Program of State University of Surabaya. Supervisor: (I) Prof. I Ketut Budayasa, Ph. D. and (II) Dr. Abadi, M.Sc.

**Keywords:** design research, spatial ability, spatial orientation, map reading, Realistic Mathematics Education (RME), Pendidikan Matematika Realistik Indonesia (PMRI)

Map reading activity is a good way to convey spatial information as well as to apply people's spatial ability, particularly spatial orientation. Map reading activities may support the development of students' spatial orientation. In order to support the development of students' spatial orientation, in the present study we designed three lessons involving the cardinal directions (north, east, south, and west) in map reading activities. We considered using cardinal direction since it is closely related to the Buginese culture. The subject of this study is 25 of 5<sup>th</sup> grade students (10-11 years old) in SD Inpres 3/77 Arasoe, South Sulawesi. The aim of this study is to contribute to a local instruction theory of spatial orientation particularly in map reading. Consequently, design research as an approach and Pendidikan Matematika Realistik Indonesia (PMRI) which was adapted from Realistic Mathematics Education (RME) were chosen to achieve the research aim. To conjecture what happens in the classroom, the Hypothetical Learning Trajectory was designed consisting of starting points, mathematical goals, mathematical activities, and the hypothesis of students' answers. Data collections were generated from the video recording of activities during teaching and learning activities, students' written works, pre-test and post-test, and an interview with students. The HLT was compared with the students' actual learning trajectory during the teaching experiment in order to analyse whether the mathematical goals are achieved during the instructional sequence. We conducted two cycles in this study. The first cycle was a preliminary teaching experiment. It involved 4 students from the same grade as the subject of the study. It aims at the improvement of the design, particularly the HLT. The second cycle was the teaching experiment involving the subject of the study. Based on the analysis of the second cycle, students were able to solve most problems in each map activity correctly, to follow the process well, as well as reach all the learning goals. Therefore, we concluded that involving students in the map reading activity using cardinal directions could support the development of students' spatial orientation.

## ABSTRAK

Ermita. 2015. *Menggunakan Arah Mata Angin dalam Kegiatan Membaca Peta dapat Mendukung Perkembangan Spasial Orientasi Siswa*. Tesis, Program Studi Pendidikan Matematika, Program Pascasarjana UNESA. Pembimbing: (I) Prof. I Ketut Budayasa, Ph. D. dan (II) Dr. Abadi, M.Sc.

**Keywords:** *design research*, kemampuan spasial, spasial orientasi, membaca peta, Realistic Mathematics Education (RME), Pendidikan Matematika Realistik Indonesia (PMRI)

Kegiatan membaca peta adalah kegiatan yang bermakna untuk menyampaikan informasi spasial dan mengembangkan kemampuan spasial seseorang, khususnya kemampuan spasial orientasi. Kegiatan membaca peta ini juga dapat mendukung perkembangan spasial orientasi siswa. Oleh karena itu, untuk mendukung perkembangan kemampuan spasial orientasi siswa, dalam penelitian ini, kami mendesain tiga pertemuan yang terdiri dari tujuh kegiatan membaca peta dengan menggunakan arah mata angin (utara, timur, selatan, barat). Kami menggunakan arah mata angin dalam kegiatan ini dengan mempertimbangkan budaya orang Bugis di Sulawesi Selatan dalam menggunakan arah mata angin dalam memberi arah. Subjek dari penelitian ini adalah 25 orang siswa kelas 5 (usia 10-11 tahun) di SD Inpres 3/77 Arasoe, Sulawesi Selatan. Tujuan dari penelitian ini adalah untuk berkontribusi dalam *Local Instruction Theory* dalam materi spasial orientasi dalam kegiatan membaca peta. Oleh karena itu, kami menerapkan *design research* dan menggunakan pendekatan Pendidikan Matematika Realistik Indonesia (PMRI) yang diadaptasi dari Realistic Mathematics Education (RME) untuk mencapai tujuan penelitian. Kami juga mendesain sebuah *Hypothetical Learning Trajectory* (HLT) untuk memprediksi hal-hal yang akan terjadi selama proses pembelajaran. HLT ini terdiri dari kemampuan awal siswa, tujuan pembelajaran matematika, dan hipotesis jawaban siswa. Data dikumpulkan dari rekaman video and audio selama proses pembelajaran berlangsung, hasil dari Lembar Kerja Siswa (LKS), pre-test dan post-test, serta wawancara dengan siswa. HLT dibandingkan dengan kenyataan yang terjadi selama proses pembelajaran untuk menganalisa apakah tujuan pembelajaran tercapai atau tidak selama implementasi. Kami menjalankan dua siklus dalam penelitian ini. Siklus pertama adalah *preliminary teaching experiment* yang merupakan pembelajaran percobaan untuk memperbaiki HLT dan detail lain dalam design pembelajaran yang dirancang. Dalam tahap ini, kami hanya melibatkan empat orang siswa SD kelas 5. Sedangkan di siklus dua, kami menjalankan *teaching experiment* yang melibatkan semua subjek dalam penelitian ini. Berdasarkan analisis siklus 2, siswa dapat menyelesaikan tugas-tugas yang diberikan pada setiap aktifitas, mengikuti proses pembelajaran dengan baik, dan mencapai semua tujuan pembelajaran. Oleh karena itu, dapat disimpulkan bahwa melibatkan siswa dalam kegiatan membaca peta dengan menggunakan arah mata angin dapat mendukung perkembangan kemampuan spasial orientasi siswa.

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Eventually, I consciously understand that this thesis is still far from being perfect. Thus, any constructive critics and suggestions will be appreciatively accepted.

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## **CHAPTER I**

### **INTRODUCTION**

#### **A. Research Background**

In daily life, people are often confronted with spatial problems, such as graphs and charts in the newspaper, drawing geometrical figures, making a floor plan, reading maps, etc. Spatial information is crucial. Clarke (2003) claimed that spatial information becomes a source of information and basis of as much as 80% of decisions related to development purposes. It means that planners and decision makers who work in development projects must have a good spatial ability to be able to derive a good decision. Therefore, it is important to support the development of students' spatial ability. Clements and Sarama (2009) stated that spatial ability of children evolves with experience and socio-cultural influences from birth until they grow up, starting even before the development of language. This spatial ability could affect children's mathematical ability, such as in geometry and measurement (Clements and Sarama, 2009). Spatial ability consists of spatial orientation and spatial visualization.

Diezmann and Lowrie (2009) argued that information graphs are very important to represent information. The information graphs involve graphs, maps, and number lines. They stated that graphical information in mathematics is related to spatial ability (mental rotation, spatial perception and spatial orientation) to decode graphs. Moreover these graphics influence the students' performance in doing mathematics. Clarke (2003) argued that maps are the best

way to convey spatial information as well as to apply people's spatial ability that is required to decode maps. Since a map is a representation in graphic form, it can also be used by children for bridging the abstract world to the real world. Diezmann & Lowrie (2009) also stated that students in the age of 10-13 find it hard to understand the information on maps while in fact we know that map reading is important and could support students' spatial ability. Moreover, Kurniadi (2013) stated that it is important to support children's spatial ability by involving them in reading map activities because there is a positive relation between map understanding and spatial ability. Thus, it is crucial to involve the students in map reading activities.

To date, there were some studies in this domain in Indonesia (Kurniadi, 2013). Kurniadi investigated how the spatial ability of the students could be improved through map activities. However, the study did not make any relation between spatial orientation and cardinal directions (the four main compass directions). In fact, the use of cardinal directions is closely related to Indonesian culture, particularly Bugis culture. Bugis is one of the tribes dwelling South Sulawesi which is the largest population compared with other races inhabiting in this province. The Bugis community is better known as sailors (Wasilah et al., 2010). Accordingly, Liebner (2005) assumed that the one of essential element in indigenous life is navigational practice, which is a concept of a spatial orientation. It was shown in the way Bugis people built their house in the past. Mostly Bugis' houses were built in the shape of rectangle (*Sulapa Eppa'*) directing one of the cardinal directions (East, West, South or North). In

addition, Bugis language which mostly involves cardinal directions in giving direction or describing position of an object, for instance if wanting to go to a place in north part of the village, they will say “*maelo’ka lokka manorang*” which means “I want to go to the North” (Liebner, 2005). This kind of culture and habitual of using cardinal directions in daily conversation could support the development of people’s spatial ability, including their spatial orientation as Boroditsky (2011) stated that language could shape one’s thought.

In this study, the researcher focused in the use of cardinal directions only without involving intermediate directions. Eventhough students had learnt this topics in the previous grade, the researcher considered to only involve cardinal direction because the four directions of cardinal directions could be a bridge for students to learn the next topic which is introduction of Cartesian coordinate system by using grid systems. In addition, in this study the researcher wanted to focus on how students orientate themselves on map. The researcher were afraid if the intermediate directions were involved as well, students will only focused on memorizing the name of directions rather than using them to orientate themselves.

Unfortunately, based on interviews with some people in Arasoe, Bone, some children still faced difficulties in acknowledging the cardinal directions in new places and even in familiar places since many children do not speak in Bugis language anymore. Some of them merely speaks Bahasa Indonesia in Bugis dialect. As a result, the children find it hard to give directions by using cardinal directions. They tend to merely use a navigation system (left, right, in

front of, and behind) when giving directions. While in Bugis language, using the terms for left and right in giving directions are not appropriate. Therefore, it is crucial to introduce and make children familiar with cardinal directions, especially in their own city or village to support the development of their spatial orientation.

## **B. Research Question**

Based on the explanation in the previous section (see Research Background), we derive the following research question: “*How can using cardinal directions in map reading activities support the development of students’ spatial orientation?*” In supporting students, we design a learning sequence consisting of some activities in map reading. The learning sequence accommodates students to apply their spatial orientation as well as leading children to have map literacy. As a result, we expect this series of learning activities could support the development of children’s spatial orientation.

## **C. Objectives of the Study**

The research aim of this study is to contribute to a local instruction theory of spatial orientation particularly in map reading. The contribution is an innovation of a series of learning activities which we called Hypothetical Learning Trajectory (HLT). The designed HLT can support the development of students’ spatial orientation.

## **D. Achievement Criteria of the Study**

Based on the research question and research aim, we integrated achievement criteria for this study as follows:



1. Students are able to orientate their own position on maps.
2. Students are able to find location of objects on maps.
3. Students are able to make and follow a route on maps.
4. Students are able to use cardinal directions in giving directions.
5. Students come up with some strategies to orientate themselves on maps.
6. Students are able to write or speak by using appropriate spatial terms.
7. Students are able to follow the learning process. In this case, it is including understanding the rules and instructions given during the learning process, asking and answering questions as well as uttering opinion and idea during discussion.
8. Teacher are able to teach and guide students to conduct the learning process.

#### **E. Definition of Some Key Terms**

Basically, it is essential to define the key terms involve in this study to avoid different or mis-interpretation for the terms and to understand the scope of this study. The key terms are as follows:

##### **1) Cardinal Directions**

Cardinal directions are the directions of north, east, south, and west. They are commonly denoted by their initial, N, E, S, and W.

##### **2) Map Reading Activities**

Map reading are activities in which people try to understand and make sense all information in a map. In this study, map reading activities refers to a series of learning activities in which students try to understand

information in maps of either familiar or unfamiliar places, including orientating their position, finding objects or places in the map, indicating the cardinal directions, and giving directions.

3) Using of Cardinal Directions in Map Reading Activities

Using cardinal directions in map reading activities in this study refers to using cardinal directions as fixed system while conducting the map reading activities, including putting the compass rose in the map, giving directions by using cardinal directions, and understanding instruction of location which utilize the cardinal directions.

4) To support

The term “to support” in this study means a way of facilitating, engaging, and stimulating the students as well as giving an assistance to the students in order to help the students improve their spatial orientation.

5) Spatial Orientation

Spatial orientation is the ability to know and comprehend the relationships between different positions in space with respect to our own position and our movement through it.

6) The Development of Students’ Spatial Orientation

Development is defined as a progress. The development of students’ spatial orientation is a progress of children’s spatial orientation according to their level of age.

## **F. The Significances of the Study**

Based on the objectives of the study, the present study is expected to contribute in the development of a local instruction theory in domain of spatial orientation. The contributions are the alternative way to support the development of students' spatial orientation as well as the description of the learning process of children in developing their spatial orientation in map reading activities.

For the teacher, the present study is used to show the teacher how the use of cardinal directions in map reading activities could support the development of students' spatial orientation.

Moreover, this study is also expected to become reference for further studies or other studies in the relevant issue.

## **CHAPTER II**

### **THEORETICAL FRAMEWORK**

#### **A. Spatial Ability**

Interest in studying spatial ability began in 1883 when Galton started his systematic psychological inquiry (Bishop, 1980). This kind of studies remains interesting up to now. Lately, the research on spatial ability is no longer merely in the field of psychology (Kozlowski and Bryant, 1977; Thorndyke and Hayes-Roth, 1982; Lehnung et al., 1998), but also in the field of mathematics education (Clements, 1998; Lowrie and Logan 2006; Lowrie, 2010; Revina, 2011; Kurniadi, 2013; Risma, 2013).

##### **1. Definition**

Spatial ability is the capacity to understand and remember the spatial relations among objects. It deals with activities and situations which involve controlling space around yourself (TALteam, 2006). Spatial ability consists of three main elements which are concepts of space, tools of representation, and processes of reasoning (National Research Council, 2006). Generally, the National Research Council (2006) describes the details of each element as follows:

- 1) *Space*, including:
  - a) the relationships among units of measurement (e.g., kilometers versus miles)
  - b) different ways of calculating distance (e.g., miles, travel time, travel cost)

- c) the basis of coordinate systems (e.g., Cartesian versus polar coordinates)
- d) the nature of spaces (e.g., number of dimensions [two- versus three-dimensional]);

2) *Representations* including:

- a) the relationships among views (e.g., plans versus elevations of buildings, or orthogonal versus perspective maps)
- b) the effect of projections (e.g., Mercator versus equal-area map projections)
- c) the principles of graphic design (e.g., the roles of legibility, visual contrast, and figure-ground organization in the readability of graphs and maps); and

3) *Reasoning* including:

- a) the different ways of thinking about the shortest distances (e.g., as the crow flies versus route distance in a rectangular street grid)
- b) the ability to extrapolate and interpolate (e.g., projecting a functional relationship on a graph into the future or estimating the slope of a hillside from a map of contour lines), and
- c) making decisions of all matters related to space (e.g., given traffic reports on a radio, selecting an alternative detour)

Based on the description above, it is clearly seen that spatial ability is also an important ability in learning mathematics, especially in geometry.

Generally, there are two main abilities in spatial ability, which are spatial orientation and spatial visualisation (Bishop, 1980 in Clements and Sarama, 2009). Spatial orientation deals with both mathematics knowledge and the ability to remember things. Moreover, spatial orientation is the ability to know and comprehend the relationships between different positions in space with respect to our own position and our movement through it. In this regard, spatial orientation deals with working on maps and coordinate systems. While spatial visualization is the ability to understand, generate, and manipulate (moving, matching, and combining) mental images of either two- or three-dimensional objects (Clements and Sarama, 2009).

## **2. The Development of Spatial Ability**

Catling (1978) stated that children's spatial ability was developed through three stages:

- 1) Topological: understanding a part-whole relationship among objects
- 2) Projective: understanding that certain objects can be placed relative to other objects, such as projective maps which represent a curved surface on a plane.
- 3) Euclidean: accurately and completely understanding relationships between objects.

In addition, Diezman & Lowrie (2009) also said that students in the age of 10-13 still have difficulties in understanding the information on maps while we know that map reading is crucial in supporting their spatial ability. The present study is focused on spatial orientation in map activities. Therefore, in

the following section, we will elaborate more on spatial orientation and map activities.

## **B. Spatial Orientation and Map Activities**

### **1. Spatial Orientation**

Spatial orientation is the ability to understand the localization of objects mentally relative to oneself, to one another, or to a fixed standard direction (such as a navigation system, cardinal directions, intermediate directions, etc). This ability helps humans to have control and move efficiently in space (Freeman (1916) cited in Lord, 1941).

A lot of studies including Risma (2013) have shown that involving children in activities acquiring spatial orientation could promote and support children's spatial ability which will eventually benefit students' education and occupational life. In line with this finding, Clements (1998) stated that spatial ability, in this case spatial orientation and mathematics achievement are related. Some studies showed that students with a good spatial orientation and spatial visualisation are more mathematically competent. In addition, Clarke (2003) claimed that spatial information becomes a source of information and basis of as much as 80% of the decisions related to development purposes. It means that planners and decision makers who work in development projects such as city planning, land transportation routes, etc. must have a good spatial ability to be able to make a good decision. Therefore, spatial orientation is an essential ability which needs to get more attention from the educators, especially teachers in preschool and primary education.

## **2. The Development of Spatial Orientation**

Developmental progression in spatial orientation in (Clements & Sarama, 2009):

**Age of 0 – 2** : Understand initial vocabulary of spatial relations and locations. In this age, infants understand standard terms related to space such as “in”, “on”, “under”, “up”, and “down”, but not in the real meaning. For instance, the infants understand the word “on” not as a position of an object on top of another, but merely to the act of making an object becomes physically attached to another.

**Age of 2 – 3** : Locate a horizontal or vertical line in space. In this phase, infants can use distant landmarks to find objects or locations near them.

**Age of 4** : Extrapolate lines from positions on both axes and determine where they intersect. At the age of four, children can locate objects after movement. In addition, when searching objects in a small area, the children often use circular search patterns.

**Age of 5 – 6** : Extrapolate two coordinates, understand their integration to one position, as well as use coordinate labels in simple situations, e.g: distances, locating objects in simple maps and locating objects in relation to one’s own position (left, right, behind, and in front of).



**Age of 7** : Read and plot coordinates on simple maps (floor plan of classroom, their bedroom, playground, etc.).

**Age of 8+** : Follow and create maps, even if spatial relations are transformed (considering directions and distances).

In Lehnung et al (1998) Piaget explained the development of children's spatial orientation. He stated that children aged 4-6 years always display an egocentric strategy (constructing a strategy in relation to themselves). Children aged 7-8 years tried to dissociate their own perspective from an object's perspective but did not fully succeed. Then, by the age of between 9 and 10 years, children were able to integrate and coordinate relational aspects of place. This claim is supported by Lehnung et al.'s (1998) study. They found that the orientation strategies used by children were different in each age group.

### **3. Relation between Spatial Orientation and Map Activities**

In his study, Lowrie (2010) found that students need to master different spatial reasoning skills in order to solve many different kinds of mathematics tasks which involve graphics or word problems. Up to now, most mathematical tasks in the primary school were word problems, whereas in the current curriculum and assessment perspective, the aim is to have more graphics based in the task representations since the use of graphics in society as well as representations of information in visual and graphic forms increase. Therefore, educators need to pay more attention to the role of representations in school mathematics. Mathematical representations are viewed as an integral

component of the ideas and concepts to understand and engage with mathematics (NCTM, 2000 cited in Lowrie, 2010)

Moreover, Lowrie (2010) stated that there are two kind of representations: an internal and an external one. Internal representations include ideas and images, while external representations include graphical representations such as charts, graphs, and maps. Diezmann and Lowrie (2009) also found that information graphs are very important to represent information. The information graphs involve graphs, maps, and number lines.

Clarke (2003) argued that maps are the best way to convey spatial information as well as to apply people's spatial ability that is required to decode maps. Since a map is a representation in graphic form, it can also be used by children for bridging the gap between the abstract world and the real world. Students need experience in decoding to make sense of all information on maps (Lowrie and Logan, 2006). Moreover, in a study of Kurniadi (2013) it is stated that it is important to support children's spatial ability by involving them in reading map activities since there is a positive relation between map understanding and spatial ability. Thus, it is crucial to involve students in map reading activities.

Involving children in various kinds of map activities could support their understanding of important concepts in mathematics, such as direction and location. Clements (1998) stated that children need to construct more sophisticated ideas about direction. Children are supposed to know environmental directions such as above, over, and behind, master relative

directions (left, right, back, and forwards) and more global directions (cardinal directions and intermediate directions). Such ideas, combined with developing distance and measurement ideas, could be developed when children experience constructing and reading maps of the environments around them. Moreover, Clements (1998) added that another important concept in the map activities, namely location, is also a very useful concept in mathematics. Therefore, involving children in working on two-dimensional maps (navigating, map reading, and map making) could help children to grasp the idea of abstraction, generalization, and symbolization as well as important ideas in mathematics such as perspective, direction, measurement, and location (Clements, 1998).

### **C. Cardinal Directions**

The tradition in which people live is the source of all our notions of orientation and direction. In addition, other aspects such as language, interaction, and cognition of the speakers are also a source of the concept of space (Levinson, 2003). Furthermore, Levinson et al in Boroditsky (2011) stated that the language could shape one's thought. The habit of using absolute directions, in this case cardinal directions in daily conversation could support the development of people's spatial ability, including their spatial orientation. People who have a habit to use cardinal directions in daily life are remarkably good at keeping track of their position even in unfamiliar places, since the requirement of their language trains and shapes their cognitive ability. Therefore, when students are regularly confronted with spatial problems involving cardinal directions, we expect that these kind of activities could support the development of their spatial ability.

## 1. Cardinal Directions in Bugis Culture

The use of cardinal directions is closely related to Indonesian culture, particularly Bugis culture. Bugis is one of the ethnic groups dwelling South Sulawesi which is the largest population compared with other races inhabiting in this province. The Bugis community is better known as sailors (Wasilah et al., 2010). Accordingly, Liebner (2005) assumed that the one of essential element in indigenous life is navigational practice, which is a concept of a spatial orientation. It is shown in the way Bugis people built their house in the past. Mostly Bugis' houses were built in the shape of rectangle (*Sulapa Eppa'*) directing one of the cardinal directions (*manorang or riattang* (north), *maniyang or lautang* (south), *rilau or timoreng* (east), and *orai or riajang* (west)). In addition, Bugis language which mostly involve cardinal directions in giving direction or describing position of an object, for instance if wanting to go to a place in north part of the village, they will say “*maelo'ka lokka manorang*” which means “I want to go to the North” (Liebner, 2005).

According to Holbrook (2012), in the past, Bugis sailors combined both the compass and celestial navigation in their voyaging. In 1962, the Bugis sailors already utilize compass on their boats. However, the use of compass was merely as a secondary check to their celestial methods. Bugis sailors believe that sea and everything connected with it must be understood well because it is the key for a safe voyage. Natural phenomenon also serve as an important sign for Bugis sailors such as the Sun's positions, constellation and moon.

#### **D. Realistic Mathematics Education (RME) in the Present Study**

In the present study, we investigate students' spatial orientation during map reading activities. Therefore, we construct a Hypothetical Learning Trajectory (HLT) to support students' development of map understanding and spatial orientation. We apply Realistic Mathematics Education (RME) as a heuristic approach. Realistic Mathematics Education (RME) is a domain specific instructional theory in mathematics education which offers a framework for teaching mathematics and interpreting students' activity in learning mathematics (Gravemeijer, 1994). It was first introduced and developed by the Freudenthal Institute in the Netherlands. Freudenthal (1973, 1991, in Gravemeijer, 2009) introduced the idea of "mathematics as a human activity." According to Freudenthal (Gravemeijer, 2009), students should be given the opportunity to reinvent mathematics by mathematizing (to interpret, organize, and construct meaning of situation with mathematical modelling). The RME theory can be described in terms of three instructional design heuristics, i.e. guided reinvention, didactical phenomenology, and emergent modelling (Gravemeijer, 1999). The first heuristic, guided reinvention, suggests that students themselves should experience the process by which mathematics was invented. The second heuristic, didactical phenomenology, is concerned with the use of phenomena to introduce concepts, tools, or procedures in mathematics. The third heuristic, emergent modelling, is related to the process of students modelling their own mathematical knowledge from the informal to the formal level (Gravemeijer and Bakker, 2006). These three

design heuristics of RME are elaborated into five tenets. Moreover, we integrate the five tenets of RME into this design, as elaborated below (Treffers, 1987, p. 225-262):

1) Phenomenological exploration

In RME, the starting point of a learning process should be ‘real’ for the students to attract their interest in the problems. The word “real” does not only mean something happening in real life, but also something which can be imagined by children or something which is real in the children’s mind (Van den Heuvel-Panhuizen, 2003). In the present study, we confront the students with spatial orientation problems in a context which is closely related to their real life, such as making an itinerary for walking around the zoo in their city or giving directions to their new friend from another city. We construct all the given contexts to engage the students in the learning process. The contexts given offer students chances to explore maps which support the development of students’ spatial orientation.

2) Bridging by using models

A model is a tool to help students bridge (generalize and formalize) a mathematical situation (phenomena) in real life to formal mathematical reasoning. In the design, we investigate students’ spatial orientation during map activities. We use maps which are one kind of geometric model in mathematics. They can be used as a representation of a model between the real world and the abstract world.

### 3) Students' own constructions and production

Students' contributions are essential in the teaching and learning activity. The students are expected to find the solution of problems by themselves. In this regard, the role of the teacher is crucial. The teacher should know how to stimulate and help the students to produce and construct their solution. Moreover, in the series of lessons we design, we expect that the students will use their experience and knowledge about the use of maps. We offer opportunities for students to choose their preferences in giving directions, reflecting the advantages and the disadvantages of the system and the routes they choose. The teacher plays an important role to stimulate the students in finding their own solution as well as doing an evaluation and a reflection of their solution.

### 4) Interactive instruction

The students' contribution, the exploration of phenomena, and modelling can only be efficient if we have interactive instruction. Therefore, the existence of interaction and cooperation among students and between students and teachers is crucial (de Lange, 1996; Gravemeijer, 1994). During the learning process in our design, we provide opportunities for students to cooperate with other students to solve the spatial orientation problems, such as finding locations, giving directions, finding a possible route, etc. Moreover, in the design we also offer an opportunity for the students to explain, justify, agree and disagree,

question, give alternatives and reflect during the whole class discussions. The teacher's role is to make sure that all students participate in the discussion.

#### 5) Intertwining of learning strands

The integration of mathematical strands or units is a crucial part of RME (de Lange, 1996; Gravemeijer, 1994). Commonly, the concepts in mathematics are related to each other. In our design, the main issue is map understanding. Maps itself are one kind of graph in mathematics, while map understanding is closely related to the spatial ability applied in mathematics, such as the coordinate system, measurement, distances, scale, etc. Moreover, this topic is also intertwined with the field of geography. Maps is an important concept in geography. In geography, the maps are introduced in many different kinds and ever more complicated since they contain a lot of different information, for instance in a climate map, a topographical map, an economic map or a resource map. Therefore, map understanding that students develop during the lessons can be applied to help them understand the maps they are confronted with in the field of geography.

Moreover, the Realistic Mathematics Education is constructed by considering the characteristic of children. Therefore, it can be considered that RME closely related to the learning style of the children. In constructing the conjectures of children's answer in the HLT we consider the learning styles of the students as well. There are many different types of this preferences elaborated by the experts. However, the most popular among them is the VARK, developed by Fleming (2001; Fleming & Mills, 1992). Its popularity comes from its face validity, its



simplicity, its ease of use, and the wealth of learning materials that have been designed to accompany it (Leite et al., 2010). There are different learning styles that are described throughout this particular assessment: Visual (V), Aural (A), and reading/writing (R) kinesthetic (K). A visual learner prefers using images, pictures, colors, and maps to organize information and communicate with others. This person can easily visualize objects, plans and outcomes in their mind's eye. People that depend on kinesthetic learning can become distracted, where visual and auditory instructional methods are significantly more common. Kinesthetic learners like to have manipulative learning materials directly in front of them so they can get a more realistic understanding of the concept that they are supposed to be learning (Gyanchandani, 2013). Because majority of children in primary school are kinesthetic learners, we consider this VARK types as a matter which influence students strategy.

#### **E. Map Reading in the Indonesian Curriculum**

The topic of map reading in the Indonesian curriculum was actually firstly introduced as a part of a social subject to increase basic competence in elementary education. In Indonesian schools it was uncommon to learn about maps as a part of mathematics. The curriculum seems to put less emphasis on map understanding as a part of spatial ability in the mathematics classroom. In this present study, we choosed 10 or 11-year-old students (grade 5) as the target group. The material used in this study was intended to support students' map understanding.

<i>Basic Competence for Grade 5:</i>	
4.8	Constructing a simple floor plan or map by considering scales, distance, and time with several possible paths and determining the objects' position by considering the cardinal directions.

The present study were integrated from this basic competence. Therefore, the present study was focused on the process of how students understand maps (and cardinal directions) and how this supports the development of spatial orientation in the mathematics classroom.

#### **F. The Role of Learning Style in the Design**

In constructing the conjectures in the HLT we consider the learning styles of the students as well. There are many different types of this preferences elaborated by the experts. However, the most popular among them is the VARK, developed by Fleming (2001; Fleming & Mills, 1992). Its popularity comes from its face validity, its simplicity, its ease of use, and the wealth of learning materials that have been designed to accompany it (Leite et al., 2010). There are different learning styles that are described throughout this particular assessment: Visual (V), Aural (A), and reading/writing (R) kinesthetic (K). A visual learner prefers using images, pictures, colors, and maps to organize information and communicate with others. This person can easily visualize objects, plans and outcomes in their mind's eye. People that depend on kinesthetic learning can become distracted, where visual and auditory instructional methods are significantly more common. Kinesthetic learners like to have manipulative learning materials directly in front of them so they can get a more realistic understanding of the concept that they are supposed to be

learning (Gyanchandani, 2013). Therefore, in the conjectures later on, we consider this VARK types as a matter which influence students strategy.

### **G. Design Research**

In this study, the researcher designed a sequence of instructional activity involving map activities to support students' spatial orientation. Based on the aim of the study, the researcher considered that the design research was the relevant approach to be used. According to van den Akker et al. (2006), design research aims at not only for practical applications and policy implications but also the developing of empirically grounded theories of a study combining the process of learning and the means supporting the process (diSessa & Cobb, 2004; Gravemeijer, 1994, 1998).

The design research is proceeded through iterative cycles of design and implementation. Each implementation is used to collect data to improve the following design. The researchers then elaborate their initial hypotheses and principles, refining, adding, and discarding through a reflection upon the design and the results (retrospective analysis). Eventually the researchers combine them together to be a coherent theory which indicate their understanding of the design experience (Edelson, 2002). Moreover, Gravemeijer and Cobb (2006) discussed the three phases of conducting a design experiment as follows:

#### *1) Preparing for the experiment*

The goals of the preliminary phase of design research can be viewed from two different perspectives. Based on design perspective, the preliminary phase of a design research experiment aims at constructing a Hypothetical Learning

Trajectory which can be elaborated and refined during the experiment. While in the research perspective, the preparation phase is viewed as a phase in which we clarify the theoretical intent of the study to support the empirical ground of the local instruction theory later on.

## 2) *Experiment in the classroom*

The second phase of design research is conducting the teaching experiment in the classroom. The goal of the teaching experiment is to test and improve the conjecture in HLT that is developed in the preliminary phase and to develop an understanding of how the design works. From the teaching experiment, the researcher collects the data which leads to the answer of the research questions.

## 3) *Conducting retrospective analysis*

The retrospective analysis is conducted for the entire data set collected during the teaching experiment. The primary aims of this analysis is typically to contribute to the development of a local instruction theory. The hypothetical learning trajectory used as a guideline and points of references in analysing the data. Therefore, during this phase the researcher go back and forth from HLT, activities, and data collected (van Eerde, 2013)

As can be seen from the explanation above, the HLT plays important role in this design research. Generally, the HLT has different functions in each phase of the design research. In the preparation phase, the HLT is used as a guideline for designing the instructional materials. In the teaching experiment, the HLT functions as a guideline for both the teacher and researcher to determine the focus of the

teaching, interviewing, and observing. In the retrospective analysis phase, the HLT serves as a guideline for the researcher to decide the focus of the analysis (Van Eerde, 2013)

#### **H. The Present Study and the Outline of the Hypothetical Learning Trajectory**

In the present study, we generated a hypothetical learning trajectory (HLT) in one of the core steps in design phase. The notion of HLT was proposed by Martin A. Simon (1995). The HLT itself is a learning and teaching framework consisting of learning goals, learning activities, and the thinking and learning in which students might engage (Simon, 1995). The learning trajectory is hypothetical because children have different way of thinking, we do not know the exact response (interpretation, strategy or idea) of students until they are really working on a problem (Fosnot and Dolk, 2001). Therefore, HLT can be viewed as a general plan and predictions about the actual teaching and learning activities. To generate a good HLT we had to predict the mental activities that students might engage in when they participate in the teaching and learning sequence we construct.

Generally, spatial orientation can be defined as an ability to know where you are and how to get around in the space, including understanding and operating on relationship between different positions in space respect to your own position (Clement, 1998). Based on this definition we derived some activities which are important part of the study. From the definition, we could notice three important points related to spatial orientation which are knowing where you are (positions or locations), knowing how to get around in the space (giving direction or route), and relationship between different positions in space (reference points). Therefore, in

the activities we conducted in the study will be emphasize on this three points by involving the use of map in each activity and the cardinal directions as a tool for students to orientate themselves. In line with this definition, the study of Clements & Sarama (2009) found that 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. Moreover, Clements (1998) stated children need to have maps in their heads, called mental maps. It is different from a paper map. It is filled with private knowledge and idiosyncrasis and consist of many kind of ideas and processes. These may be organized into several frames of references. Therefore, in the study we also included an activity in which students were assigned to fill the blank map of their village. This kind of activity could support the students to build a mental map of their village. Within this activity, we also involved cardinal directions to help the students orientate location of places on the map.

Moreover, we arranged the activity based on the complexity of the map and the task. As can be seen from Table 2.1, in the first lesson we used a simple map with smaller scale of area (map of shool). Then, in the second lesson, students used map of the city which is quite large but having many information on it to help the students do the task. Moreover, we used map of village in the third lesson. Even though the depicted area on the map is smaller than is in the second lesson, the assignment in this lesson much more complex and difficult for the students since

there were limited information on the map which could support the students to finish the task.

Based on the theory explained above and some considerations we described the outline of the Hypothetical Learning Trajectory of the study in the following Table 2.1.

**Table 2.1:** The Outline of the HLT

<b>Task</b>	<b>Activity</b>	<b>Hypothesized Results</b>
Finding locations on a simple map	Playing Scavenger Hunt by using the map of the school	<ul style="list-style-type: none"> <li>• Students develop their spatial orientation by utilizing cardinal directions and relative system to find the objects</li> <li>• Students develop different strategies in orientating their location or position on map.</li> </ul>
Reading and using map of unfamiliar place	<ul style="list-style-type: none"> <li>• Completing the map of Makassar based on the instructions</li> <li>• Making an itinerary for spending 1 day in Makassar</li> </ul>	<ul style="list-style-type: none"> <li>• Students develop their map reading skills for larger area</li> <li>• Students develop their spatial skills, especially spatial orientation (finding location, giving direction, describing location or position of places)</li> <li>• Students develop their spatial language (spatial terms, sentences in giving directions, sentences in describing locations or position, etc.)</li> </ul>
Building mental map of familiar place	<ul style="list-style-type: none"> <li>• Finding locations of familiar places on the blank map (using map of the village where students live)</li> <li>• Dividing the area of the village based on cardinal directions</li> </ul>	<ul style="list-style-type: none"> <li>• Students develop their spatial skills by recognizing their village better</li> <li>• Students construct a mental map of their village so they know the location of important places on map of village easily</li> <li>• Students develop their map reading skills.</li> </ul>

In addition, teacher's role is indeed crucial in this study. We elaborated the teacher's role in more specific in the elaboration of HLT. In general, the role of the teacher in this study was generated from Gravemeijer (cited in Zulkardi, 2012). There are four roles, which are as a facilitator, an organizer, a guide, and an evaluator. Teacher should guide the learning activities well and present the given context to the students. In addition teacher should lead the wholeclass discussion as well as encourage students to actively give their contribution. Another important role is teacher as a bad advisor. It means that sometimes teacher did not give any judgement to the students answer and giving questions instead of answering students' question.

Moreover, Kurniadi (2013) claimed that involving students in map activities could improve students' spatial ability, particularly spatial orientation. Therefore, we hypothesised that the map activities we designed could support students' spatial orientation as well. This study addressed the following research question: *How can using cardinal directions in map reading activities support the development of students' spatial orientation?*



## **CHAPTER III**

### **METHODOLOGY**

#### **A. Research Approach**

Design research is conducted to create an innovation in the learning activity. The present design research aimed at contributing an innovation for the improvement of mathematics education in Indonesia in general. Moreover, the aim of the present study was to contribute to a local instruction theory of spatial orientation particularly in map reading. The study focused on the following research question: *“How can the use of cardinal directions in map reading activities support the development of students’ spatial orientation?”* In this study, the researcher designed a sequence of instructional activity involving map activities to support students’ spatial orientation. Based on the aim of this study, the researcher considered that the design research was the relevant approach to be used. The three phases of our design research are as follows:

##### *1) Preparing for the experiment*

In this phase, initial idea was inspired and elaborated by studying literature such as journals, articles, and books which are related to the spatial orientation and maps reading. Based on the literature review, the researcher decided the learning goals, end points, and the starting points of the study to design the learning activities. In addition, we also added conjectures of students’ response. This sequence of learning activities including conjecture of students’ thinking and strategies served as the initial Hypothetical Learning

Trajectory (HLT). Moreover, the conjectures in HLT could be changed and adjusted to students' actual learning process during the teaching experiments.

## 2) *Experiment in the classroom*

In this phase, the researcher implemented the sequence of activities developed in the preliminary phase within one cycles. The first cycle was conducted as a pilot study involving merely a small group of students in the teaching and learning activities. The purpose was to adjust and to improve the sequence of activities that have been developed. The adjusted and improved sequence of activities was used in the next cycle of teaching experiment. Moreover, in the second cycle, we implemented the sequence of activities in the natural classroom environment. The mathematical content of the teaching experiment in the first cycle remained the same since the second cycle was the revision of the first cycle. The teacher and researcher discussed about the upcoming activity to adjust and make agreement about how the lesson might be delivered based on the teacher and researcher point of view before conducting a teaching experiment. After each lesson, the researcher conducted reflection about the learning process regarding the positive and negative points.

## 3) *Conducting retrospective analysis*

The retrospective analysis was conducted for the entire data set collected during the teaching experiment. The main aims of this analysis was to contribute to the development of a local instruction theory. In this phase, the researcher used the hypothetical learning trajectory as a guideline and points of references in analysing the data. The HLT was compared with the actual

teaching and learning process of students in the classroom. The descriptions in the analysis were not only about the instances which supported the conjectures, but also the ones which contradict with them. Eventually, the conclusion was derived from the retrospective analysis was used to answer the research questions. The product in this phase was not only the description about how map reading activities can support the development of students' spatial orientation, but also to develop a more effective instructional activity on developing the students' orientation.

## **B. Data Collection**

Based on the research question, we decided to use four different methods of data collection, i.e. interview and classroom observation. The data collected were students' written work, interview, field notes, and videotaped observation. Since the aim of this study was to elaborate how we can support students' development of spatial orientation, the data were analysed qualitatively.

### **Target Group**

The data were collected in one of primary school in South Sulawesi. The target group was 29 students of 5<sup>th</sup> grades of elementary school in Arasoe, a village in South Sulawesi, Indonesia, namely SD Inpres 3/77 Arasoe, and a classroom teacher of the 5<sup>th</sup> grade SD Inpres 3/77 Arasoe. We involved four of the students in the first cycle and the other 25 students in the second cycle. Those four students in the first cycle were grouped into two small groups consisting of two students.

## **1. Preparation phase**

This phase was the starting point of the study. In this phase, the researcher collected some different data to get more information. The preparation phase is as follows:

### **a. Classroom observation**

A classroom observation was conducted before the interview with the teacher. The aim was to obtain more relevant information for the design, such as the teacher's and students' activities and the interaction among students and between teacher and students. The researcher recorded the whole process by using a video recorder and takes field notes during the observation. The classroom observation was guided by the list of topics which was prepared beforehand (see Appendix C).

### **b. Interview with the teacher**

Interview with the teacher was conducted after the classroom observation. The interview was guided by the list topic (see Appendix B). The aim of this interview was to confirm the information we obtained in the classroom observation. During the interview, the teacher could clarify the classroom culture, students' prior knowledge, the teacher's understanding of our topic, and some other relevant important information. The interview was recorded by audio recorder and field notes which were taken during the interview

## **2. Preliminary teaching experiment (first cycle)**

The first cycle of the design was conducted by grouping the four students of grade 5 into two small groups consist of two students. We involved different

students from whom we worked with in the second cycle. The aims of the first cycle were to test the conjectures in the initial HLT and to improve the design which was implemented the second cycle (real teaching experiment).

In these cycles, the researcher became the teacher. The teaching and learning process was also recorded by using the video recorder. Moreover, the researcher collected the written work of students.

### **3. Teaching experiment (second cycle)**

In the second cycle, the revised design of the first cycle was used. This cycle was conducted in one class of 5<sup>th</sup> grade in SD Inpres 3/77 Arasoe. The researcher focused on the development of one group of students consisting of four students. During the teaching and learning process, the researcher collected data by using two cameras. One camera was focused on the focus group and another camera for recording the whole class activities. The outline of activities in each lesson of this phase can be seen in Appendix A. In addition, the researcher took field notes during the teaching and learning process. In this cycle, the regular teacher applied our design in teaching and learning process in the classroom.

### **4. Pre-test and Post-test**

#### **a. Pre-test**

Pre-test was conducted before the teaching experiment. The purpose of this test was to assess the knowledge of the students about the topic. The participant of pre-test was all students in the teaching experiment class. In this test, students worked individually to solve some problems related to map reading involving cardinal directions and spatial orientation which was the topic of the study. The

items in the pre-test and post-test consisted of ten open questions related to map reading.

b. Post-test

Similarly, the post-test also involved all students in teaching experiment class. The purpose was to know the development of students' achievement after the design was applied. Students solved some problems related to map reading involving cardinal directions and spatial orientation. The number of items and the content of the items in the post-test was same as in the pre-test.

## **5. Validity and reliability**

The quality of the studies was based on their validity and the reliability of the data collection and data analysis. In this research, we considered the validity and reliability and classified them into five which are as follows:

- a. Internal validity is mostly associated with the quality of data. In the present study, we considered collecting various data such as interview, observation, field notes, students' written test, and video recording. The validity of the finding later on can be checked and confirmed by using different source of information.
- b. Ecological validity; van den Akker (2006) stated that a central assumption that underpins our work was that instructional innovations developed in a design research experiment can be used effectively to support students' learning in other classrooms. Briefly, the results should provide a basis for adaptation to other situations. In this sense, this study was carried out in the natural classroom settings.

- c. Internal reliability is associated with the reliability within the study. We considered the use of video recorder as well as one observer to improve the internal reliability due to the consistency of data collected.

## **C. Data Analysis**

### **1. Preparation phase**

- a. Classroom observation and interview with teacher

The teacher interview and the selected interesting fragments of the video in classroom observation was transcribed and analysed (see Appendix B and C). The interesting fragments were the fragments in the video which show the evidence of the claims we stated in data analysis. The purpose was to find out the description about to get the relevant information such as, classroom's culture, students' prior knowledge, teacher's and students' activity, the interaction among students and between teacher and students during the process, therefore, we could see what social norms applied during the teaching and learning activities. These observation criteria were defined in terms of both verbal and non-verbal behaviours.

- b. Pre-test

In analysing the pre-test, we focused on the strategies used by students to solve the problems about map reading in the written test. The students' solution in each problem was investigated and identified as a particular level of students' spatial orientation. The analysis was done in qualitative way. The results of this analysis was taken into account for the improvement of HLT and for seeing the development of students' spatial orientation.

## **2. Preliminary teaching experiment (first cycle)**

During the analysis, we selected interesting fragments from video recording and the interview was transcribed and analysed to consider the content of HLT. The interesting fragments were the fragments in the video which confirmed what we predicted in the HLT or something happened which we did not predict in HLT. The reflection of this analysis was the starting point for a teaching experiment in the second cycle. The finding of the analysis of preliminary teaching experiment shaped the idea about activities, the level of students and the possibilities of the education setting in HLT. Therefore, it led to the improvement of HLT including the conjectures and the teaching sequence.

## **3. Teaching experiment (second cycle)**

In the second cycle of teaching experiment we collected various data in each lesson, such as video recording, field notes, and student' written work. Some interesting students' written works were selected to figure out how students solve the problem and to test the conjectures in HLT. The researcher watched the video registrations of each lesson and transcribed the transcript of the interesting fragment video. The fragments was used to describe the group discussion or the classroom discussion and to analyze the students' contribution. In addition, the field notes were written in lesson reports which identified the important parts of classroom discussion to the particular students in the learning process of all lessons. Eventually, the results of the analysis led to the conclusions which answered the research question.

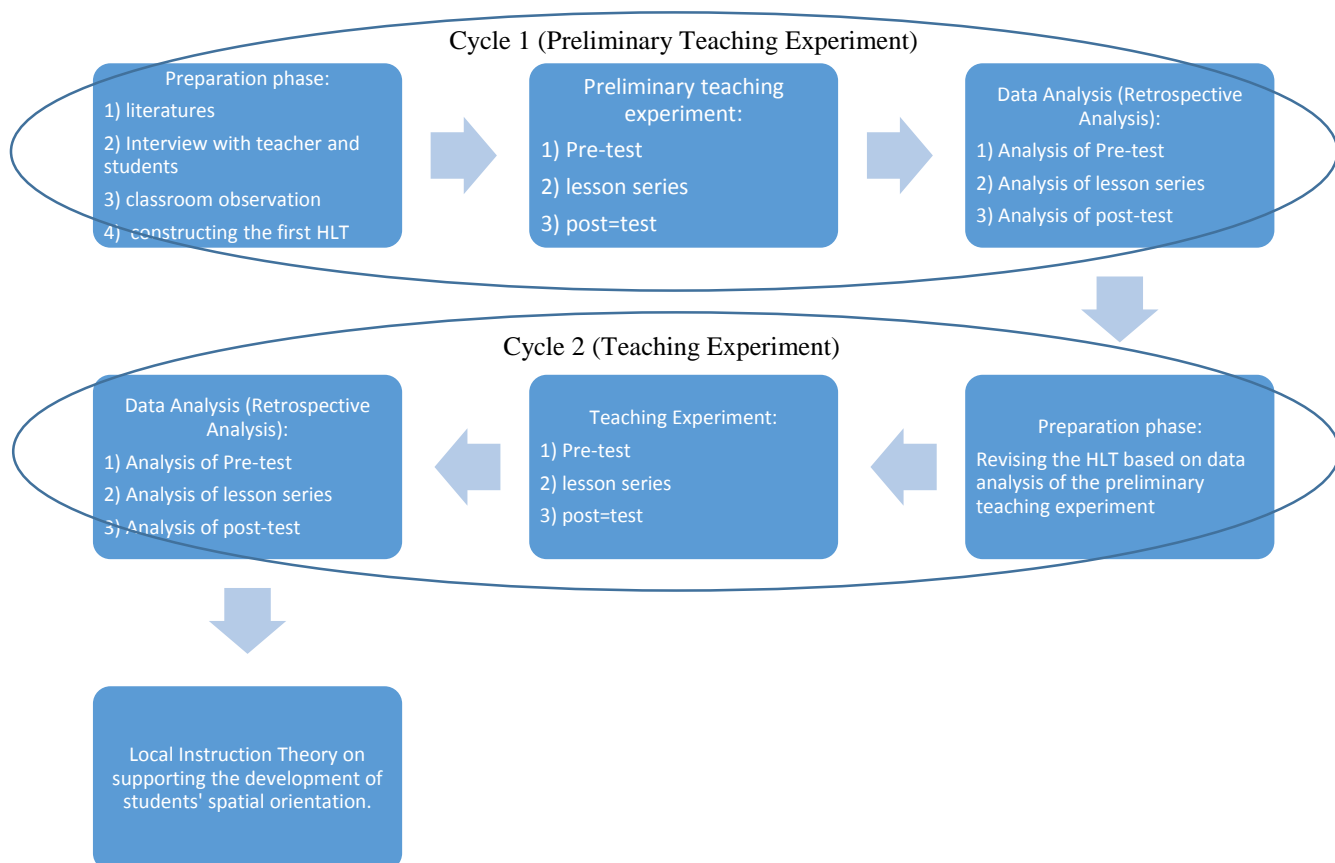


#### 4. Post-test

The researcher analysed and compare the result of pre-test and post-test after the second cycle of teaching experiment. The result was analysed qualitatively. This finding was used to support the conclusion drawn in the analysis of the teaching experiment.

#### 5. Scheme of How the Study was Conducted

The following scheme shows how we conducted our study:



## **6. Validity and reliability**

During retrospective analysis phase, the researcher also considered the quality (validity and reliability) of the data analysis. It was elaborated as follows:

- a. Internal validity: During the analysis, the researcher tested conjectures that were derived from different data material such as fields' notes, interesting fragments of teaching and learning video, transcript of the interview, and written tests.
- b. External validity concerns related to the generalizability or transferability of the finding from the specific contexts to other contexts as well as the results of study whether it can be generalize in such a way that other researcher can adjust them to their own local settings.
- c. Internal reliability is associated with the consensus of some parties regarding the findings (interpretation and conclusion). It was improved by conducting peer review and consultation with experts.
- d. External reliability refers to the trackability of the data (whether people could follow and understanding what we did and reported). The research must be clear in such a way the reader can track the learning process and reconstruct the study.
- e. Ecological validity; this research was carried out in the natural classroom settings in the second cycle of teaching experiment. Furthermore, since the researcher and teacher were collaborated in the research, it was also strengthen the ecological validity of this study.

Generally, the researcher described each step in the present study in detail and systematically in such a way; consequently, it offered possibility to other researchers to replicate the learning process and draw the same conclusion through the cycles of teaching experiments and data analysis.

## **CHAPTER IV**

### **RESULT AND DISCUSSION**

#### **A. Preliminary Teaching Experiment**

##### **1. Data of Preparation Phase**

Before conducting teaching experiment, the researcher observed the classroom and interviewed the teacher. We conducted classroom observation firstly and it was followed by interviewing teacher afterward. The classroom observation aimed at seeing the process of teaching and learning naturally run in the class involving in the study. The observation focused on what the teacher and students did during the process, how teacher and students interacted each other as well as how the students interacted among them, and lastly what classroom culture applied in the classroom. In more detail the guide for classroom observation can be seen in Appendix C. Meanwhile, the interview was to confirm and to clarify data collected during the observation and to have knowledge of teacher's point of view about the teaching and learning process. Moreover, the complete list of questions during the interview can be seen in Appendix C.

##### **a. Classroom Observation**

Classroom observation was conducted on March 13rd, 2015. The classroom observed is a classroom of 5<sup>th</sup> grade students' consisting 25 students. The lesson's duration was 70 minutes. During the classroom observation, the researcher found that the teacher accustomed with direct

teacher method in which the teacher has to explain the theory and concept to the students. The teaching and learning process was focused on procedural skills rather than the conceptual matter. However, the students in this class presumably familiarized working in group because the students' seats originally were arranged in group, not in individual or pairs seats.

In the beginning of the lesson, teacher prepared a poster on which the material discussed at the time. On poster, teacher provided pictures and examples of addition and subtraction in fraction. However, the poster's size seemed too small and unreadable from students' seats' distance. Teacher asked the students to read the poster carefully and asked the students whether they had questions about it. Then, teacher explained all the materials on poster as well as the examples on it. While the teacher gave explanation, none of the students talked or made a sound. They seemed very well behaved. However, we were not sure whether they all understood the explanation. Next, teacher wrote two questions on the board and pointed two students to solve it. After students solved the problem, teacher asked other students whether the answer correct or incorrect. Teacher then moved to group working and handed the worksheets out to the each group. While working on the problems in worksheet, students seemed focused and having serious discussion in their group. Teacher walked around to see what the students did and filled the assessment paper. However, the classroom was still silent during the

discussion. Most students had discussion by whispering. After finishing the problem, each group was asked to present their answer in the front. The group presenters were chosen by teacher. The students presented their answer by writing their solution on the board. Then, teacher asked other group whether the answer correct or incorrect. If it was incorrect, the other group came in the front and revised their counterpart's answer. After discussing all the questions on worksheet, teacher closed the lesson by drawing conclusion of the material.

Regarding the social norms, this classroom was very silent. The teacher seemed trying hard to involve students during the process, but the students stayed silent. It was presumably due to the social norms applied by teacher. The students have no confidence to utter their opinion because they were afraid to make mistakes. As it shown in the class, the teacher gave special appreciation for the correct answer and tended to ignore the incorrect one. The good thing was the students were accustomed working in group, so generally they did shared idea within their group members and communicate opinion well. However, the discussion was still dominated by smarter students. Other remarks was when the teacher posted a question, the students directly yelled the answer together. But if the teacher asked them to rise their hand to answer, none of the students did.

The other concern was the socio-mathematical norms. It was shown that the discussion's purpose was to find the correct answer. Most of the solutions of the problem were merely about applying the formula and the

number without any reasoning or discussing the related concept. The exercises themselves did not trigger the students to perform reasoning for their solution. Therefore, it was hard to find the sophisticated answers from the students.

#### **b. Interview with the Teacher**

The interview was conducted in the same date as classroom observation which was March 13rd, 2015. The general topic of this interview was about teacher's background, the classroom management, and students' knowledge about our topic. The teacher has experienced quite long time in teaching in primary school, almost 7 years. The teacher's education background is a bachelor degree in teacher education for primary school. It was already her second year teaching in 5<sup>th</sup> grade. She before taught in 2<sup>nd</sup> grade. Therefore, she already had experience teaching map reading and cardinal directions in primary school. However, those kind of material were taught in social class instead of mathematics class. Regarding the PMRI, she did not know anything about it at all.

The teacher applied direct instructional in teaching mathematics. She starts by explaining the topic and giving examples. Then, she asks the students to solve problems both individually and in group. She always prepares worksheet and some textbooks as the source in teaching. The solutions and the answers of question on worksheet are often discussed in a classroom discussion in order to find the correct one. Regarding the way

to group the students, the teacher said she divided the students into heterogenic group and the smartest student will be the leader of the group.

Based on the interview, the teacher also said that the students' ability in her class can be included into three groups which are high, middle, and low ability. However, the highest percentage of students' ability is in the middle level. Moreover, related to the topic, teacher said students already learnt a bit in the previous grade. However she was sure that there were many students still have difficulties because this kind of material has short duration in the curriculum. Therefore, the students did not learn it deeply.

### **c. The Elaboration of the Hypothetical Learning Trajectory (HLT)**

In this section, we discuss about the practical aspects of the HLT in the present study. We elaborate the HLT that is used and revised during the study. The HLT is implemented during the phase of teaching experiment in the fifth grade of primary school in Indonesia with the basic competence "*constructing a simple floor plan or map by considering scales, distance, and time with several possible paths and determining objects' position by considering the cardinal directions.*" The main learning goal of the lessons in HLT is to support the development of students' spatial orientation through a sequence of map reading activities. To reach the intended learning goals, we designed a sequence of activities that in three lessons. The three lessons include the map reading activities such as, playing scavenger hunt by using map of school, making itinerary of visiting Makassar by considering all information in map, and exploring



map of the village. Each lesson has each step which support to accomplish the learning goals which we discuss in more detail in the next part of this chapter. We also generated the hypothetical learning processes that we think are more likely to occur in the actual learning process.

Here, we will describe the hypothetical learning processes for all learning activities by describing the starting point of students, the learning goals, the mathematical activities, the conjectures of students' reactions and the students' solution procedures.

Regarding the students' starting point, based on literatures and curriculum, we know that students acknowledge the notions of cardinal directions. However, they do not have much experience in using them. Students also have experience in using compass to indicate cardinal directions. In their third year in primary school, students are already taught the relative system (go straight, turn left, turn right), so they acquainted with this system already. In terms of map reading, some students still find it difficult to read and translate all the symbols used in maps. Moreover, some students also still have difficulties to orientate their position in maps.

### **1) Lesson 1: Using Cardinal Directions in Playing Scavenger Hunt**

#### **Learning goal**

1. Students indicate a direction using cardinal directions.
2. Students are able to read the simple map
3. Students are able to find a location in maps (their own location and location of objects)

## **Classroom culture**

During the lesson, teacher gives chances for students to express their idea and opinion. Students should be stimulated to discuss and react to what others say since during the teaching and learning process students should work in team work.

## **Description mathematical activity**

This set of activities offers an opportunity for students to discuss how they determine cardinal directions, see how this idea related to their daily life and apply this knowledge along with their spatial ability in solving problems.

### ***Activity 1***

First activity is as warming up in which the teacher asks the students to utter everything they know about cardinal direction.

1. Teacher asks students to close their eyes and point the north.

#### *Conjecture of students' answer*

- Students will point different directions.
  - Some students point the wrong direction.
  - Some students point the right direction based on their experience and knowledge
2. Teacher asks the students a question how to prove the direction they point is correct.

- How could you know that direction is north?
- What can we use to be sure that the direction we indicate is the right direction?

*Conjecture of students' answer*

- Students think that north is always in their front. (When encountering this situation, teacher could ask the students, “When you are in the different place, for instance you sit in the class II, you will face different direction. Then based on your argument, the north is in the opposite direction. So do you think the cardinal directions keep changing based on our position?”)
- Students use certain landmarks in the school (e.g.: school’s Musholla (place for do prayer) as a base since commonly in Indonesia it faces west direction)
- Students propose the use of the Sun’s position.
- Students suggest magnetic compasses.
- Students experienced using cardinal directions in the school area.

3. Teacher gives short responds to the students’ answer (use of landmarks and the Sun’s position).

***Activity 2***

The second activity the students are offered an opportunity to use the Sun’s position to determine cardinal directions.

1. Teacher recall students’ answer in the previous section about indicating cardinal directions by using the Sun’s position.

2. Teacher shows a picture of children standing in the field. They backs the Sun. At that time the Sun is setting.

3. Teacher describe the problem related to this context.

“Last weekend, I took picture of children in the field near my home. I took a picture of them playing football while the Sun sets. One of the boy stood backs the Sun. Here are the pictures I took when I was there. What do you think from the picture which could help us to indicate the cardinal directions? Can you figure out in which direction the direction they were facing to? What direction in their left and right side?? Discuss this in your group.





Figure 4.1: Students' Worksheet activity 2, Lesson 1

4. Teacher shows the pictures in the story.
5. Teacher gives students the worksheet.

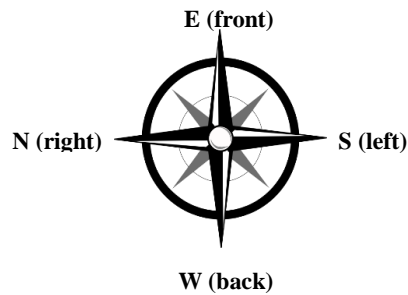
***Students' worksheet:***

Look at the pictures. The picture was taken when the Sun sets. One of the boy stood back the Sun.

1. Now, can you figure out in which cardinal direction the boy is facing? Explain your reasoning!
  2. What direction in his left and right side?
  3. In which directions will the Sun's be in the dawn? If respecting to the cardinal directions, which directions is that?
  4. Make the sketch of the cardinal directions the boy faced.
6. Teacher asks students to discuss the problem with their partner.

***Conjecture of students' answer:***

- The boy faces the east
- In his left side is north and his right side is south.
- In front of the boy. It is in the east
- They make sketch, as follows:



7. Teacher asks students to share their idea and other students are given chance to give questions.

### ***Activity 3***

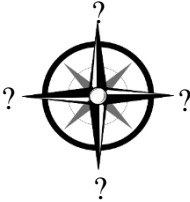
This set of activities offer students an opportunity to apply the ability they acquire in the previous meeting. They will play a game called *Scavenger Hunt*. The students are asked to find some objects and give sign on the position of objects on the map based on the given clues.

1. Teacher informs the students that in this section they will play a game by using map.
2. Teacher explain the rule of the game to the students.
  - Students should solve the problems by discuss it within their group.
  - Students need to find five objects which are put in certain locations in the school by using map of the school.
  - Students need to find the object based on their turn.
  - In some location, there will be other objects which are not the the evidence.
  - Students need to go outside the classroom to find the position of objects.

- The list of objects and their positions will be given in the instruction sheet.
  - Before finding the object, students need to solve the first problem which is determining the cardinal directions in map.
3. Teacher gives the map for each group of students as well as the clues of the position of each objects.

Gerbang utama sekolah

Pos



Taman Sekolah

R. Guru

R. Sholat    Kelas II    Kelas I

R. Kepala Sekolah

Kelas III

Kelas IV

Kelas VI

Lapangan Sekolah

Tempat parkir

SD Inpres 12/79 Arasoe

Toilet

Kelas VA    Kelas VB

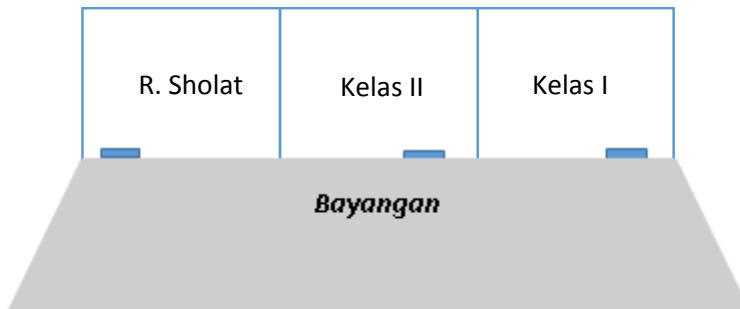
Perpustakaan

Kosong

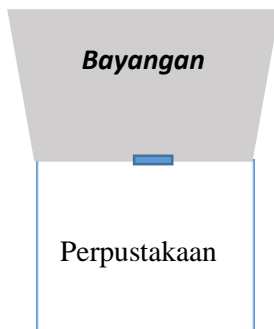


### **Instructions**

In the dawn, the classroom building shadow is as follows:



When the Sun sets, the shadow of school's library is as follows:



**Object 1:** From your position right now, go straight to the north and turn left. You will find the class IV building is in the eastern side of the object 1 and the class VA building is in the southern part of object 1

**Object 2:** if you are standing in the position of object 1 and walk to the east, you will find object 2 situated exactly in the southern side of “Ruang Sholat”.

**Object 3:** From object 2's position, face the west and go straight. Object 3 is exactly in front of the room in front of you.

**Object 4:** object 4 is situated in the eastern part of the school. It is in the northern side of the main gate of the school, in the southern side of class I building and in the eastern part of the school's park.

**Object 5:** stand in the location of object 4 and face the west. You merely need to go straight and turn right. When seeing library in front of you, stop and object 5 is in the northern part of the library.

Questions:

- 1) Determine the cardinal directions of the map
- 2) Find the location of objects and give a cross sign (X) in map
- 3) Collect all objects in max. 15 minutes and write the list of the objects.
- 4) Give the direction from your location to the object 3 (the last object)

*Conjecture of students' answer:*

Question 1:

- Students determine cardinal directions correctly.
- Students determine cardinal directions incorrectly

Question 2:

- Students mark the position of objects correctly.
- Students mark the position of objects incorrectly

Question 3:

- Some students can finish the task in the given time.
- Some students cannot finish the task in the given time.

Question 4:

- Students give direction by using cardinal directions only to explain position of objects, such as *“I go outside the class 5A. I walk to the northern part of the school until passing the path between class 2C and the library. The object 5 is in the west side of the language laboratory.”*
- Students give directions by using relative systems only to explain position of objects, such as *“I go outside the class 5A. I go straight until*

*passing the path between class 2C and the library. The object 5 is in the right side of the language laboratory.”*

In this case, teacher needs to pay attention to the students’ answer, which is probably different (the left and right of every student) based on their body’s position

- Students combine cardinal directions and relative systems to explain position of objects
  - Students use landmarks to explain position of objects
4. Teacher shows larger picture of the map in front of school.
  5. Teacher opens class discussion about students answer.
  6. Teacher asks each group to mark the position of objects on the larger map.
  7. Teacher asks the students to discuss the differences among the answers
    - Why do you think your answers are different?
    - Do you find it difficult to find the object? Why?
    - Which one do you prefer to give directions? Relative system or cardinal directions? Why?

*Conjecture of students’ answer:*

- Students realise some answers are wrong.
- Students find it difficult since they cannot imagine where exactly the position in the maps.
- Students make mistakes in determining the cardinal directions.

- Some students prefer giving directions by using relative system rather than cardinal directions since they know directly where the left are and right side just by using their hand.
  - Some students prefer giving direction by using the cardinal directions since sometimes the relative system will be tricky because it will be different based on the speaker's position.
  - Some students decide to combine both systems.
8. Teacher responds students' answer and emphasis that both systems are very helpful. In addition, the students need to pay attention to the relative system which is sometimes confusing since it is relative based on the speaker's position.
  9. Teacher explains that students can use different ways to give directions, including using cardinal directions (based on the Sun's position and magnetic compass), relative systems, use of landmarks, or combination of them.
  10. Closing the lesson

Teacher reflects the lesson by asking some questions:

- What do we learn?
- What do you think the benefit of playing this game?

## **2) Lesson 2: Exploring the Map of the Unfamiliar Place**

### **Learning goal**

1. Students are able to find a location in maps
2. Students are able to find the most efficient way to get around in unfamiliar place

3. Students are able to apply their spatial skills to solve problem

### **Classroom culture**

Teacher gives chances for students to express their idea and opinion. However, students should raise their hand if they want to express their opinion and ask questions. In this meeting, the students should work in team while solving the problem.

### ***Activity 1: Completing the Tourist Map of Makassar***

#### **Description of mathematical activity**

In this activity the students are required to complete the tourist map of Makassar by naming the buildings, sites, or streets which have been labelled. The instruction given will use both cardinal directions and relative systems. Therefore, in completing the task, students will apply their spatial orientation.

1. Teachers explain what students will do in this activity.

Your class planned to have three days study tour to Makassar and Malino. The headmaster's son working in Tourism Agency helps us to arrange the tour. He gave us the tourist map of the city and the instruction. However, the map is not complete, many labels are missing. Now, use the given instruction to complete the tourist map of Makassar to make your class' study tour easier.

2. Teacher gives the map as well as the instruction for each group of students.



## Instructions

From Bone, you will pass Bantimurung. Go straight until you find “Tol Reformasi”. In the north side of the street you can see the “Pelabuhan Paotere”. Then you will find cross road, turn left to “Jl. Yos Sudarso”. Go straight to the “Jl. Andalas”, in your left you will see a “church”. In the north of the church, you will see “Makam Diponegoro”. Go straight until you find Masjid Agung. Then, turn left to “Jl. Bulu Saraung”. Go straight to “Jl. Ahmad Yani”, “Lapangan Karebosi” is in the south of the street. Go straight until you find the sea and go to the south, “Jl. Ujung Pandang”. In the west of the street you will see “Fort Rotterdam”. Continue your journey

along the shore. You will see “mercure” in the east of the “Jl. Pasar Ikan” as well as “Hospital 1” and “Masjid” in the south of the mercure. Go straight to “Jl. Gagak” and turn left to the “Jl. Kakatua” in which a famous *Coto* restaurant situated. In the north of Jl. Kakatua, you will see “Gelora Andi Mattalatta”. Then, turn right and “Hospital 2” is in your left. Continue to go straight and after passing the cross road, in your right, you will firstly find “Pasar Pabaeng-baeng” then secondly a “Terminal Bus”. Continue your journey to the southern part of the city, after 2 hours, you will reach Malino.

### **Questions:**

Based on the instruction above, find the sites, buildings, or the streets which are mentioned in the instruction

*Conjecture of students’ answer:*

- Students answer the question correctly
  - Students answer the question incorrectly
3. Teacher opens classroom discussion about students’ answer.
  4. Teacher asks students’ difficulties while solving the problems.

*Conjecture of students’ answer:*

- Students might find this problem difficult since it is hard for them to imagine themselves moving in the city.
- Students might get confused in following instruction and understanding the map.

In facing this situation, the teacher could ask the students to really move their body based on instruction instead of just imagining it in their head. The teacher also could ask other students to re explain the situation and help their counterpart to understand the instruction.

5. Teacher then continue the class to the second activity.

### ***Activity 3: Planning an itinerary***

This set of activities offer students an opportunity to arrange a plan go around Makassar in a day. They need to consider the important things, such as the attraction, Musholla, place to have lunch, etc. Therefore, they need to make sense all information on map and plan a scenario for that. In this activity, students are required to apply their spatial orientation to find the solution.

1. Teacher informs the activity which students are going to do in this activity.
2. Teacher explain what students should do.
  - Students plan a way in go around the city of Makassar.
  - Different ways are allowed as long as students have good reason and explanation for that.
  - Students need to consider all information on the map.
3. Teacher gives the worksheet.

### **Questions**

- 1) Make a plan how you will spend your day in the city. (*Mind all important aspects such as the attraction, Musholla, place to have lunch, etc*).
- 2) Explain the direction from your starting point to the end point. (*You may use cardinal directions or the relative systems*)



4. Teacher ask the students to present their answers.

*Conjecture of students' answer:*

Question 1)

- Students draw the line in the map which represent their way to go around the city.
- Students come up with different solutions and reasons.

Question 2)

- Students give direction by using cardinal directions only to explain their way
- Students give directions by using relative systems only to explain their way
- Students combine cardinal directions and relative systems to explain their way
- Students use landmarks to explain their way
- Students combine cardinal directions, relative systems, and landmarks

5. Teacher ask the students to paste their work in the board.
6. Teacher then opens class discussion for the question 1
7. Teacher asks students to explain their solution and the reason why they choose it.

*Conjecture of students' reasoning:*

- The shortest distance in go around the city, but visiting most of the famous sites
- They still have their lunch in restaurant and pray in Musholla on time.

- It needs shortest duration.
8. Teacher asks one or two groups to explain their plan to get around the city and ask other group whether they could follow the instruction made by those groups.
  9. Teacher open classroom discussion to revise (if needed) each groups' answer, such as the chosen words or sentences in giving direction whether they are clear enough or no.
  10. Closing the lesson
 

Teacher reflects the lesson by asking some questions:

    - What do we learn?
    - What do you think the benefit of this activity?

### **3) Lesson 3: Constructing the mental map of Familiar Place**

#### **Learning goal**

1. Students have general idea about the map of the village they live.
2. Students are able to identify locations on a map.
3. Students are able to apply their spatial skills to solve problem

#### **Description of mathematical activity**

##### ***Activity 1***

This activity offer students the opportunity to construct their own mental map of the village hence the students have general idea of the map of Arasoe. In this activity, students are required to use their knowledge and their experience to fill in the name of place in the blank map of the village.

1. Teacher shows the map of Arasoe in front of the class.



2. Teacher asks the students whether they recognize the map.

- Is there any of you recognize what map is this?

*Conjecture of students' answers:*

- 1) Students do not recognize that it is the map of Arasoe
  - 2) Students recognize it is the map of Arasoe
3. Teacher tells the students that it is the map of Arasoe.
  4. Teacher explains that in this meeting they are going to explore the map of their village.
  5. Teacher hands the blank map of the city.
  6. Teacher asks the students to make group of four children.
  7. Teacher hands the worksheet in.
  8. Teacher asks each group to discuss and give the name of the areas or spots in map as many as they could recognize as well as the reasoning of their answer.

*Conjecture of students' answers:*

- 1) Students know some locations in the map because they ever saw it before.
- 2) Students find some locations in map by using the information given in the map, such as the position of other villages and the cardinal directions.
- 3) Students do not any spots in the map.

(Teacher tells them to pay attention to the other villages' position and ask students whether they know the place nearby those villages. Moreover, teacher could stimulate students' reasoning by pointing the one village in the map and ask the students what place in Arasoe near that village. In addition, teacher asks the students to remember the previous lesson using map of the school. Because students already familiar with the cardinal directions in school, they could help the students to use that knowledge to help them)

9. Teacher asks two or three groups to present what they discuss.
10. Teacher asks other groups whether they have questions or remarks to their fellow students' discussion.
11. Teacher asks additional question about the location of some landmarks in Arasoe.
  - Could you find where the positions of Pabrik Gula Bone, Traditional Market, Masjid Makmur, the cane field, and your school?

*Conjecture of students' answer:*

- 1) Students find out all the landmarks by using the information they have
- 2) Students have difficulties in finding the landmarks

(In this case, teacher could help the students by giving the position of other places near by the landmarks)

12. Teacher shows the blank map with the answers of the students and compare it with the original map of the village.
13. Teacher opens discussion about the location of places found by students to check whether they locates them correctly.
14. After labelling the map of the village, teacher asks students to divide the area in the map of the village respect to cardinal directions.

*Conjecture of students' answer:*

- Students divide the map respect to the cardinal directions

15. Teacher asks students' difficulties in identifying locations on map.

*Conjecture of students' answer:*

- Students find it hard to orientate a position by merely using map.
- Students are not familiar with the village yet.

16. Teacher opens class discussion.
17. Teacher asks students to explain their answer and how they get them in order to help other students who still find it difficult to interpret the map.
18. Closing the lesson: Teacher reflects the lesson by asking some questions:
  - What do we learn?

What do you think the benefit of this activity?

## 2. Preliminary Teaching Experiment

The preliminary teaching experiment was conducted in three meetings.

The following table shows the schedule in the first cycle.

**Table 4.1:** Schedule of Cycle 1

<b>Data Collection</b>	<b>Date</b>
Pretest and interview	March, 16th 2015
Lesson 1	March, 18th 2015
Lesson 2	March, 19th 2015
Lesson 3	March, 20th 2015
Posttest	March, 21st 2015

During the preliminary teaching (first cycle) we tested out the designed instructional activities and type of instruction in the initial HLT into two small groups consisting two students in each group. These students were from the 5<sup>th</sup> grade of SD Inpres 3/77, Arasoe. The researcher acted as a teacher in this cycle. Observations and analysis about what is going on during the preliminary teaching was made and conjectures that are embodied in the instructional activities were evaluated based on the remarks and findings during the process to improve the initial HLT.

## 3. Retrospective Analysis

### a. Pre-test

Before the first lesson of the first cycle, we conducted a pre-test. Students took this test in 30 minutes and worked individually. This test purpose is to get an impression of their prior knowledge about the map reading and the concept of cardinal directions, which was important information for the implementation of the HLT. Afterward, we conduct an

interview to each student to know what strategy they used in solving problem in the pre-test. The result of the pre-test and the interview is described as follows:

- 1) Students had difficulties in determining the position of each cardinal directions on compass rose. They know that “north and south” and “east and west” are pairs (always put on the opposite direction). However, when north are given, they barely put the position of west and east correctly. This case was found in the four students who were subjects of the study. As a result, none of the students could answer the questions about identifying locations correctly.
- 2) Students had difficulties in stating as well as writing proper words or sentences in giving direction and explaining position. We presumed that students hardly found this kind of problem in their mathematics or other subjects’ classroom. As a result, students were not familiar enough with the words used in spatial orientation problems.

#### **b. Lesson 1: Using Cardinal Directions in Playing Scavenger Hunt**

This lesson consisted of three activities. The first and the second activity was to discuss the rudimentary idea of cardinal directions. Meanwhile, the third activity was to provide experience for the students to use cardinal direction in map reading.

##### **Activity 1: Where is the North?**

The first activities' purpose was to identify what students know about cardinal directions (North, South, West, and East) and how to determine

them. In this first activity, the students worked individually. In the first activity, students were asked to identify north and gave argumentation about that. While asked to point to the North, all students point with their finger to the front of them (which was south). When asked by the researcher, students uttered their explanation showing their misunderstanding about the position of north in real life. The following fragment 4.1 shows how the student, namely Aldha gave her argumentation.

**Fragment 4.1. Pointing the North**

- |   |              |  |
|---|--------------|--|
| 1 | Researcher   | : Okay. Because all of you had pointed same direction, so I could ask anybody how they are sure they point north, right?   |
| 2 | Researcher   | : Student 1, please. Please explain to us why did you point that direction as north? ( <i>Point the direction pointed by Aldha</i> ). How could you know that this direction is north?   |
| 3 | S1_A         | : Because...(laughing)   |
| 4 | Researcher   | : If someone asked you, how could you know this direction is north? What would you tell them then?   |
| 5 | S1_A         | : <b><u>Because the upper side is the north.</u></b>   |
| 6 | Researcher   | : So, you mean it is always in your front? How if I face this direction? ( <i>Change the position of seat facing other direction</i> ). Then, my north will be different from yours? So, this direction will be north as well? |
| 7 | All students | : No.  |

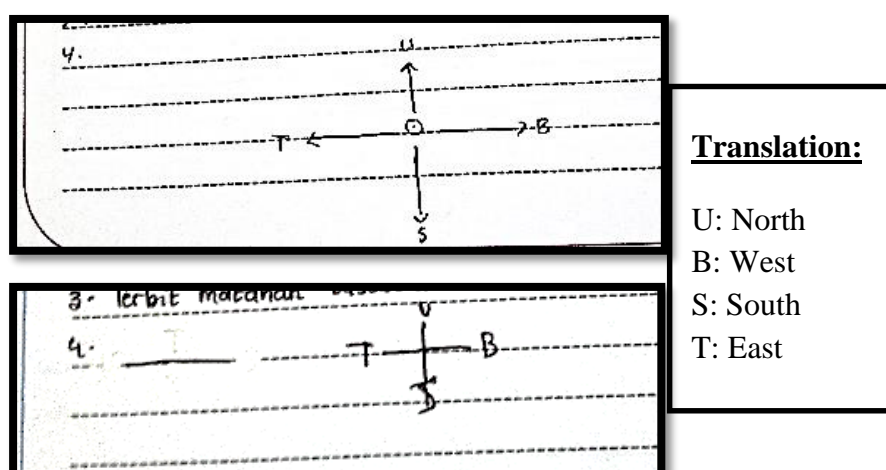
As shown in Fragment 4.1, the student seems mixing up the concept of cardinal directions on map and in reality. Based on her argumentation (line 5, fragment 4.1), the student presumably reversed to the map reading she experienced in her social class. Because most map put north in the upper side, she thought that north in real life always in the front of her as



well. Moreover, none of the students could utter their reason why they all point the same direction as Student 1 pointed. The researcher then asked the students the way to determine cardinal directions without using magnetic compass. None of the students could answer the question. They all looked confused to answer it.

### Activity 2: The Sun's Position and Cardinal Directions

In the second the students worked in pairs. This activity was to introduce the students, the way to identify cardinal directions by using Sun's position. The students were given a picture of group of boys playing football when the Sun sets. Then, students were assigned to determine the cardinal directions based on the information given in one picture. Within this activity, the researcher found out that all students had difficulties in putting each cardinal directions in compass directions. The following figure 4.2 shows how the both groups made mistakes in putting west and east in the compass' rose.



**Figure 4.2.** Group 1's written work (*up*) and group 2's written work (*down*)

### **Activity 3: Playing Scavenger Hunt**

The third activity which was the highlight of this lesson was aimed to make the students to consider cardinal directions in finding location. In this activity, students played Scavenger Hunt in which they were assigned to find the location of five objects in the map of their school. The given instruction used both cardinal directions and relative systems.

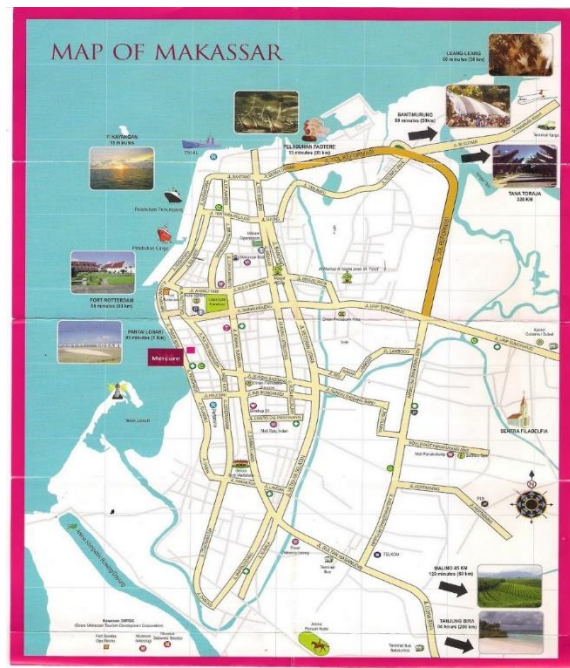
In the activity 3, the students went out the classroom to find five objects around the school area. Unfortunately, this outdoor activity did not run as what researcher wanted. The students focused on finding objects without paying attention to the cardinal directions and the given instructions. Moreover, other students from other class doing outdoor activity at the time kept talking and telling the students (subject of study) the locations of object. The students did not want to go back to the class and insisted to find all the objects. As a result, this activity was very time consuming and did not reach the goals of the lesson. We think that this problem might occur due to the lack of verbal instruction from the researcher about what students should do. Even though, we prepared worksheets, students still needed detail explanation from the teacher. Moreover, another reason may be due to the situation of the school. Because the area of the school is not that large, students easily saw the location of the objects and saw where another group went, so they followed where another group went. It triggered the students to merely collect the

objects instead of understanding the instruction and using map. Generally, this activities did not turn out as what the researcher wanted.

Based on the analysis, we concluded that students still faced difficulties in determining cardinal directions. Regarding the map reading ability of the students in this lesson, we could not explain any conclusion because the activity involving map reading activity did not run as what it should. Therefore, the instructional activity in the lesson 1 needed some refinements for the next cycle, particularly in the activity 3, we will refine some details, such as the instruction and the questions. The researcher also decided to make the activity became indoor activity since difficulties found during the activity.

**c. Lesson 2: Exploring the Map of Unfamiliar Place**

This lesson consisted of two activities. Both activities' purpose was to provide students chances to apply their spatial ability, particularly their spatial orientation by exploring map of an unfamiliar place, in this case map of Makassar as shown in figure 4.3 below.



**Figure 4.3:** Map of Makassar

These map reading activities were considered as good activities to support the development of students' spatial orientation. The activities in this lesson also provided students an opportunity to deal with maps which contain many information on it. Moreover, the activities could support students to understand that symbols on map representing things in the space. Within these activities, students could identify the reference points while identifying locations. Students could get the idea that when using cardinal directions, they used other locations as their reference point while in relative system they use their body position as their reference.

#### **Activity 1: Completing the Map of Makassar**

The first activity was aimed to give a chance for students to find some locations on the map (see Figure 4.3). In this activity, students were

assigned to find some locations of place on the map. The given instruction used both cardinal directions and relative systems. The example of the instructions were as follows:

*... Go straight to the “Jl. Andalas”, in your left you will see a “church”. In the north of the church, you will see “Makam Diponegoro”. Go straight until you find Masjid Agung. Then, turn left to “Jl. Bulu Saraung”. Go straight to “Jl. Ahmad Yani”, “Lapangan Karebosi” is in the south of the street. ...*

While solving this problem, the students seemed following the instructions quite easily. Both group did not show any specific strategy which we conjectured in HLT, such as turning map following the directions or moving body to follow directions. Students could easily imagine when they needed to turn right or left in map as well as to follow the instructions using cardinal directions. However, one group had difficulty in identifying the exact location of places on map. The fragment below shows how the students’ struggle in identifying the exact location on map of Makassar. In this fragment, students struggled to identify the location of “Church” on the map (see the instruction in the previous paragraph).

#### **Fragment 4.2:** The Location of Church

- 1 S1\_D : (*pointing the map*) You will pass the church... church.
- 2 S1\_D : What if I there are no church on map, Mam?
- 3 Researcher : You could not find it? Then, it is your task to name it.
- 4 Researcher : Where is the location of church on the map?
- 5 S1\_D : In the left side of Jl. Andalas
- 6 Researcher : Okay, write it down.
- 7 S1\_D : So, I write it here? (*pointing empty space on the map near the correct location*)



not know yet that in completing the map, they needed to label symbols instead of a mere random empty space on the map. Meanwhile students from another group could follow the instructions and label the symbols correctly without any obstacles.

Based on all description above, we concluded that students did not have any difficulties in understanding and following instructions. However, some students found difficulties in determining exact locations of place on the map. Nevertheless, this kind of activity could support the development of students' spatial orientation and map reading ability.

### **Activity 2: Making an Itinerary for Study Tour**

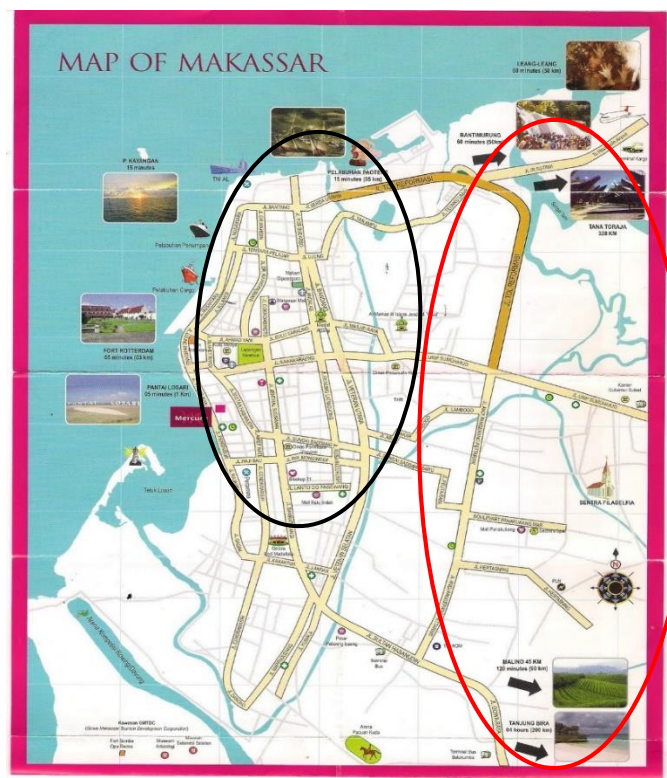
This activity offered students an opportunity to arrange a plan go around Makassar in a day. They need to consider the important things, such as the attraction, Musholla, place to have lunch, etc. Therefore, they needed to make sense all information on map and planned a scenario for that. In this activity, students were required to apply their spatial orientation to find the solution.

Students seemed excited while doing this problem. Both groups were involved in serious discussion of what places they wanted to visit and route they wanted to take. The following fragment shows group 1 discussion of what route they wanted to take.

#### **Fragment 4.3: Route from Makassar to Malino**

- 1      S1\_A                    : How if we take this route? From Bantimurung... this way... this way...*(pointing the shortest route from Bantimurung to Malino on the map (see the red circle on figure 4.4))*

- 2 S1\_Y : What? (*laughing*)
- 3 S1\_A : (*laughing*) So, what way do we take then?
- 4 S1\_Y : This way (*pointing the way to the center of the city in which there are more sites and places* (see the black circle on figure 4.4))
- 5 S1\_A : If we take this, we directly arrive at Malino. (*pointing on map* (see the red circle on figure 4.4))
- 6 S1\_Y : (*inaudible*) (*pointing the route chosen by student 1, but in the middle turning to left to go to the centre of the city*)
- 7 S1\_A : Okay, let's write it.

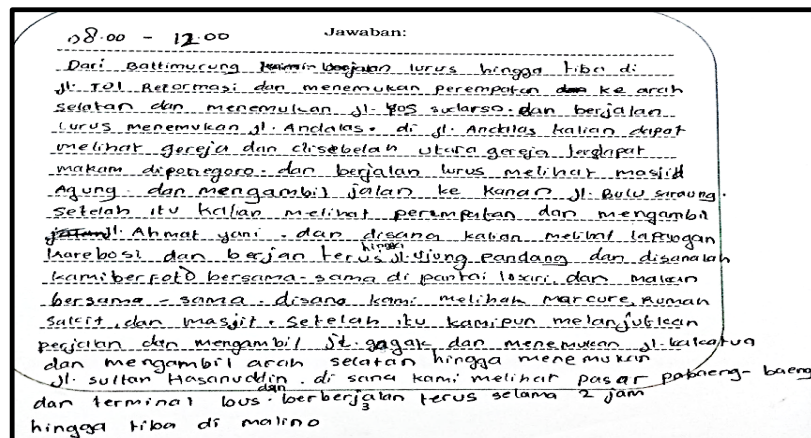


**Figure 4.5:** Route to Malino

Fragment 4.4 shows that each student have different preference in making the itinerary. Student S1\_A seemed preferring the shortest distance while student S1\_Y presumably considered the places which wanted to visit. Therefore in the end, they both decided to take shortest distance but they still



could visit some interesting places in the city. However, their discussion seemed continued and the decision seemed changed. We presumed that it was due to problem language. Both students presumably found it hard to make good sentences. It was seen in their worksheet. They chose similar route as in the previous problem, but with only one place visited. The worksheet is in the following figure:



### Translation:

From Bantimurung. We go straight until you find "Tol Reformasi" and find a cross road, go south and you arrive at "Jl. Yos Sudarso". Go straight to the "Jl. Andalas you will see a "church". In the north of the church, you will see "Makam Diponegoro". Go straight and you will see Masjid Agung. Then, turn left to "Jl. Bulu Saraung". Go straight to "Jl. Ahmad Yani", we will see "Lapangan Karebosi". Go straight to "Jl. Ujung Pandang" and we stop at Pantai Losari to take picture and have our lunch. We will see "mercure", "Hospital 1" and "Masjid". Then, we continue our trip to "Jl. Gagak" and find "Jl. Kakatua". Go south until "Jl. Sultan Hasanuddin" where we could find "Pasar Pabaeng-baeng" and "Terminal Bus". Go straight, after 2 hours, we will reach Malino.

**Figure 4.6:** Students' written work

Meanwhile, the group 2 seemed having no problem with the assignment as well as the language. They chose their own route and explain the route clearly.

Based on the description above, we concluded that while doing the activity students occupied their spatial ability in general to solve the problem. Nevertheless, this kind of activity could support the development of students' spatial orientation and map reading ability because the students were required to make a route and explain it in their own word as well as considering position of certain locations on map respecting to others' location.

#### **d. Lesson 3: Constructing the Mental Map of Familiar Place**

The lesson 3 consisted of two activities. Both activities aimed at developing and constructing a mental map of the village where the students live. In more details, the activities' purpose are to help the students having general idea about the map of the village they live by identifying locations on a map with the help of cardinal directions and by applying their spatial skills.

##### **Activity 1: Finding Familiar Places' Location on the Map**

In this activity, students are required to use their knowledge and their experience to fill in the name of familiar places in the blank map of the village. Students were given a blank map of their village (see Figure 4.7).



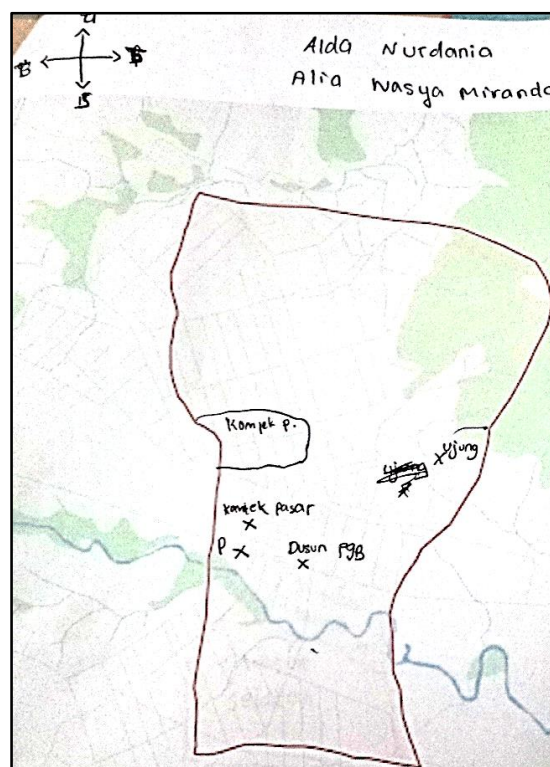
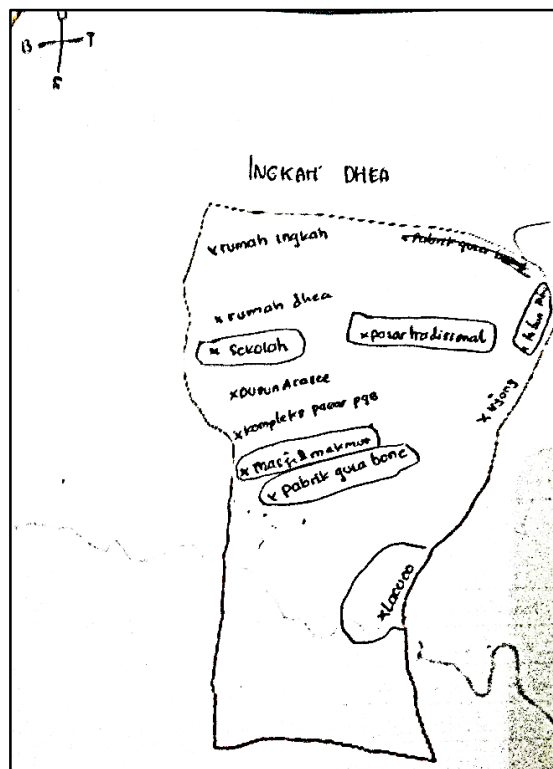
**Figure 4.7:** Map of Arasoe

During this activity, we found out that none of the students knew the map of their village. It is shown in the following fragment:

- 1     Researcher     : I took this picture from Google Maps (*showing the map of Arasoe*). Anyone recognize this map? What area is depicted on this map? Have you ever seen this map before?
- 2     S1\_A            : (*looked unsure and smiling*) Jakarta?
- 3     Researcher     : Why do you say this is the map of Jakarta?
- 4     S1\_A            : It looks like that one. I think I've seen it before in TV. (*smiling and scratch her head*)
- 5     Researcher     : Oh...you've seen the map of Jakarta before. (*Smiling*). Anyone wants to give other answers?
- 6     S1\_A            : Or is it map of Bone\*? (\*a/n: The regency where they live)
- 7     Researcher     : Others? Give your guess.
- 8     All students    : (*smiling*)
- 9     Researcher     : Okay. I'll tell you. This is the map of Arasoe. You've seen this before in your test I gave you, right?
- 10    All students    : (*nodding and smiling*)

**Fragment 4.4:** Map of Arasoe

From the fragment 4.4, we can presume that the students were not familiar enough with the map of their village. They were hardly encounter problems in the class which involve the map of the village. The activity was continued by asking the students to find locations of other familiar places on the map. The students found this assignment difficult. Therefore, the researcher added some information, which is the location of Masjid near the school and the locations of nearby villages. The researcher also reminds the students about assignment they did in the first meeting. The researcher asked the students to use their knowledge of cardinal directions in the school area to find other places' location. After given this guide, the students added some more locations they identify on the map. Figure 4.8 shows students' written work during the activity and figure 4.9 shows the original map of the village.



**Figure 4.8:** Group 1's written works (*up*) & Group 2's written work (*down*)

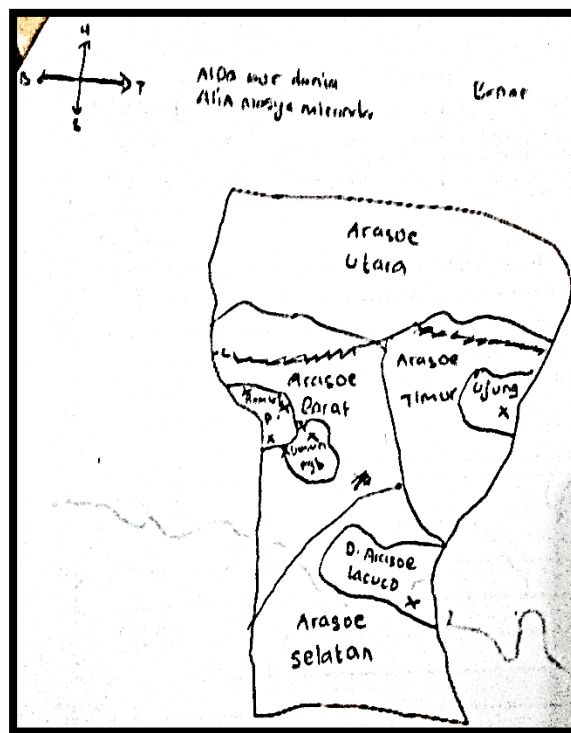


**Figure 4.9:** Map of Arasoe

Figure 4.8 above shows that none of the group found the exact locations on map. However, if paying attention on the work of group 1, we could see that students did used their spatial orientation to orientate some locations. They used their knowledge of cardinal directions in positioning location of some places. As they know the location of “Masjid Makmur”, they used them as reference point to position other locations on the map. Therefore, we could conclude that this kind of location could support students to apply their spatial orientation in constructing a mental map.

## Activity 2: Dividing the Area of the Village based on Cardinal Directions

After finding many locations on map, the next activity was to divide the area of village based on cardinal directions. This activity could support the students to have general picture of the village in their mind because they could easily see what places in the southern part of village, in the eastern part of village, in the southern part of village, or in the western part of village. Figure 4.10 depicts how the student divide the area of village based on cardinal directions, including the location of some important places in the village.



**Figure 4.10:** Students' written work, dividing area of village

Based on the analysis, we conclude that the activities in lesson 3 could support the development of students' spatial orientation by constructing a mental map of the village where the students live. One thing which need to be underlined in this lesson that teacher's role are very crucial in guiding the

students to achieve the goals of the lesson. Another remarks is that, this lesson is better to be put in the second meeting right after lesson 1 in which students playing Scavenger Hunt in the school. The reason is the students' memory about cardinal directions in the area of the school are still fresh while we construct the mental map of village. Therefore, students will be triggered to use the knowledge of cardinal directions in the school area to construct their own mental map of the village. As a result, we decided to switch the order of lesson 2 and lesson 3.

**e. Post-test**

After the third lesson in the first cycle, we conducted a post-test. Students took this test in 30 minutes and worked individually. This test purpose is to knowing their recent development of spatial orientation after getting involved in the learning activities, instead of comparing their prior knowledge with the recent ones. The result of the post-test is described as follows:

1. Students could give directions and explain locations on map by using cardinal directions and relative system in a good sentence.
2. Students could position each cardinal direction on compass rose correctly.
3. Students could follow instructions using cardinal directions and relative systems.
4. Students could read and understand information on the maps.



#### **f. Discussion and Conclusion of the Preliminary Teaching Experiment**

Based on the analysis for the three activities, we pointed some remarks to revise the HLT for the teaching experiment in the cycle 2 (teaching experiment in the bigger classroom setting). We made an improvement in some activities as well as some additional details. Moreover, the students' answer and responses in this initial teaching experiment were elaborated in the next HLT. Some remarks as follows:

- 1) For lesson 1, activity 1, we found there was a student thought that north in real life always in the front of her. Therefore, we will add this conjecture in the next HLT as well as the way teacher should respond this kind of answer.
- 2) Within the lesson 1, activity 2 the researcher found out that all students had difficulties in putting each cardinal directions in compass directions whereas this knowledge is very crucial in map reading. Therefore, in the next HLT we will emphasize this information and asked the teacher to pay more attention to this matter.
- 3) In the lesson 1, activity 3, students still faced difficulties in determining cardinal directions. Regarding the map reading ability of the students in this lesson, we could not explain any conclusion because the activity involving map reading activity did not run as what it should. Therefore, the instructional activity in the lesson 1 needed some refinements for the next cycle, particularly in the activity 3, we will refine some details, such as the instruction and the questions. The instruction to find the

location of objects was revised. The instruction was no longer consecutive instead we made it separated for each object's location. Moreover, the researcher also decided to make the activity became indoor activity since difficulties found during the activity.

- 4) Meanwhile in the lesson 2, activity 1, some students found difficulties in determining exact locations of place on the map. Therefore, we will add this students' response to the conjectures in the next HLT as well as how the teacher could react.
- 5) Moreover in the lesson 3, in both activity 1 and activity 2, the thing which need to be underlined in this lesson that teacher's role are very crucial in guiding the students to achieve the goals of the lesson. Another remarks is that, this lesson is better to be put in the second meeting right after lesson 1 in which students playing Scavenger Hunt in the school. The reason is the students' memory about cardinal directions in the area of the school are still fresh while we construct the mental map of village. Therefore, students will be triggered to use the knowledge of cardinal directions in the school area to construct their own mental map of the village. Consequently, we decided to switch the order of lesson 2 and lesson 3.

## **B. Teaching Experiment**

### **1. Preparation Phase**

In the preparation phase we improved the HLT based on the analysis of preliminary teaching experiment (see page 72-75). In addition, we had

discussion with the experts about the teacher guide and the worksheets. Therefore, we added some details and improved some parts of the teacher guide and the worksheets. Because we realized the crucial role of the teacher, we also held meetings with the teacher in order to discuss the teaching experiment and the details. These meetings were aimed at avoiding the misunderstanding of the teacher about our design and its details.

## 2. Teaching Experiment

The second teaching experiment was conducted in the 5th grade of SD Inpres 3/77 Arasoe in South Sulawesi. There were three lessons with 25 students and one teacher involved in this cycle. The teacher was the home room teacher, Ibu Rohani. During this teaching experiment, teacher implemented the HLT improved from the result of analysis of the cycle 1. In addition, the teacher and the researcher decided one group as the focus group (group of students which was main focus in the study) by considering their ability in mathematics.

**Table 4.2:** Schedule of Cycle 2

<b>Data Collections</b>	<b>Date</b>
Pretest and interview	March 23rd, 2015
Lesson 1	April 7th, 2015
Lesson 2	April 8th, 2015
Lesson 3	April 9th, 2015
Posttest and interview	April 10th, 2015

### 3. Retrospective Analysis

#### a. Pre-test

Before the first lesson of the second cycle, we conducted a pre-test. 25 students took this test in 30 minutes and worked it individually. This test purpose is to get an impression of their prior knowledge about the map reading and the concept of cardinal directions, which was important information for the implementation of the HLT. The test consisted of 10 questions (see Appendix D) which can be classified into four groups. Each group of questions has its own purpose. The purpose of each item are in the following table 4.3.

**Table 4.3:** Items in the Pretest

Items	Purpose
Question 1	To check whether students give direction by utilizing cardinal directions;
Question 2 and question 3	To check the preference of students while explaining position of an object respect to other objects (what system they use);
Question 4 – Question 7	To check the ability of students' mental movement and their familiarity with cardinal directions;
Question 8 – Question 10	To check students' familiarity with the map of the village they live.

Based on the result of the pre-test, we found that most of the students are quite familiar with the cardinal directions and almost 70% of the students utilized cardinal directions in giving directions. Moreover, most of students did not use cardinal directions only, but also utilized other systems such as using important landmarks or relative systems (up, down, left, right, front, and back). However, while answering question 2 and question 3, students had difficulties

to explain the exact position of objects respect to other objects. They hardly made clear explanation of location of place on map. Meanwhile, in answering question 4, question 5, question 6, and question 7, more than 50% of the students made mistakes. It shows that the students had problems in either doing mental movement or following the instruction involving cardinal directions. Regarding the familiarity with the map of the village, based on students' answer in question 8 and question 9, we presumed that most students were quite familiar with the map of the village they lived because they recognized most places on map. However, students' answer in question 10 showed that most students seemed have difficulties in explaining position and giving directions. Students presumably faced language difficulties because formal Bahasa Indonesia is their second language. Most students made strange sentences which were hard to be understood.

Regarding the focus group's result in the pre-test is described in more detail as follows:

- 1) Students had difficulties in stating as well as writing proper words or sentences in giving direction and explaining position. We presumed that students hardly found this kind of problem in their mathematics or other subjects' classroom. As a result, students were not familiar enough with the words used in spatial orientation problems.
- 2) Two out of three students made mistakes in finding locations on map. It was either due to the difficulties in doing mental movements or difficulties in following instructions involving cardinal directions

- 3) The three students were familiar enough with the map of the village they live. It was proven by their answer in question 8 and question 9. The students recognized many places on the map.
- 4) Based on the interview, we found out that students are quite familiar with the use of cardinal directions in their daily life since the adults in the family use cardinal directions in giving directions. However, students themselves did not regularly use them as what adults do.

**b. Lesson 1: Using Cardinal Direction in Playing Scavenger Hunt (Map of School)**

Lesson 1 consisted of three activities. Briefly, the purpose of the first and the second activity was to discuss the rudimentary idea of cardinal directions and the third activity aims at providing experience for the students to use cardinal direction in map reading activity.

**Activity 1: Where is the north?**

The first activities' purpose was to identify what students know about cardinal directions (North, South, West, and East) and how to determine them. Teacher brought this topic to the whole class discussion. When teacher asked the students to utter what they know about cardinal directions, many students participated to give their answer. The discussion is shown in the fragment 4.5 below.

**Fragment 4.5:** Students' prior knowledge about cardinal directions

- |   |         |   |
|---|---------|---|
| 1 | Teacher | : What do you know about cardinal directions?             |
| 2 | S_AY    | : It has four directions.                                 |
| 3 | Teacher | : Okay. Good. Anyone can mention what they are?           |
| 4 | S_FA    | : ( <i>raise her hand</i> ) North, east, south, and west. |

- 5 Teacher : Yes. So, there are four directions of cardinal directions.  
What are they? Anyone can repeat the answer?  
6 S\_VR : North, east, south, and west.  
7 Teacher : Good. All of you have given the good answers.

From the fragment 4.5, we could see that most students were acquainted with cardinal directions. Based on the interview with the teacher, the students learnt the material in the social class in 4th grade. In the line 4 and line 6 in the fragment, we noticed that students memorized the four directions by moving clockwise from north to the west, rather than memorized it in pairs (north and south, east and west). It becomes beneficial for the students while putting each direction in compass rose. As what we found in cycle 1 (see figure 4.2), if the students memorized it in pairs, they will end up at this kind of mistake (see figure 4.2). Because most students memorized the cardinal directions with this method, none of them made mistakes in putting cardinal directions in compass rose on map.

The activity was continued by asking the class to point to the north. Most students confidently point with their finger to the front of them which was north. Some of them point different directions but changing it immediately after peeking other students' finger. From this result, we cannot assume that all students were sure that the directions they point was north because when the teacher asked them to give their reasoning, none of the students could give proper explanation, instead a student gave their answer as in the following fragment 4.6.

- 1 Teacher : Then, how do you indicate that the direction you pointed just now is north? Anyone can give an explanation?  
2 All students : (*silent*)

- 3 Teacher : How are you sure that the direction is north?
- 4 All students : (*silent*)
- 5 Teacher : Now, all of you need to think what the reason you point the direction. Anyone? Raise you hand please.
- 6 All students : (*silent*)
- 7 Teacher : (*point one student*) Try to explain please.
- 8 S\_AY : (*smile and turn to her friend to ask*)
- 9 Teacher : I just want to to explain the way you indicate the direction you pointed. Anyone? (*point the S\_AY again*)
- 10 S\_AY : If we face the east, north is in our left.
- 11 Teacher : Okay. Any other explanation?
- 12 All students : (*silent*)

**Fragment 4.6:** Student's explanation how to indicate north

Fragment 4.6 shows that all students presumably were not sure yet that the direction they pointed was north. It can be seen from the vague explanation they gave while asked. Some students presumably had similar misunderstanding as we found in cycle 1 (see fragment 4.1), but because the position of north was coincidentally in the front of them, they ended up pointing the correct directions. While some students peeking the other students' finger might just follow other answer without knowing the reason. Moreover, we also consider that most students probably were not familiar yet about giving reasoning. As what we found during the classroom observation, the teacher tended to focus on the finding correct answers while teaching rather than asked the students to give reasoning. Therefore, we assumed that students were confused how to give their explanation.

Because the teacher saw that all students were confused and did not give an explanation, the teacher then continued the activity by explaining that there were many ways to indicate cardinal directions. The teacher then



asked the class again what those ways were. The discussion is shown in the following fragment 4.7.

- 1 Teacher : Okay. Anyone could tell me what can we use to indicate cardinal directions?
- 2 S\_FY : (*raise her hand*)
- 3 Teacher : Yes please.
- 4 S\_FY : By using magnetic compass.
- 5 Teacher : Okay. Good. Everyone knows compass right? It can be used to indicate the cardinal directions. Anyone could give other way? You've learnt this in social class when you were in grade 4 right? If I change my question, how to indicate the west?
- 6 S\_FI : We could see the Sun set.
- 7 Teacher : Yes. The Sun sets in west. What else?
- 8 S\_YS : It's qiblat so we could see what direction faced by the Masjid.
- 9 Teacher : Yes. We could use qiblat which is also west.
- 10 S\_YS : If I know the east, then I could easily find the west which is behind me.
- 11 Teacher : Good. All the answers are correct.

**Fragment 4.7:** How to indicate cardinal directions

From the fragment 4.7 we could see that the students already knew many different methods to indicate cardinal directions. One students even utilized the relative system to find cardinal directions (Fragment 4.7, line 10). He used relative system to explain and indicate positions of certain cardinal directions.

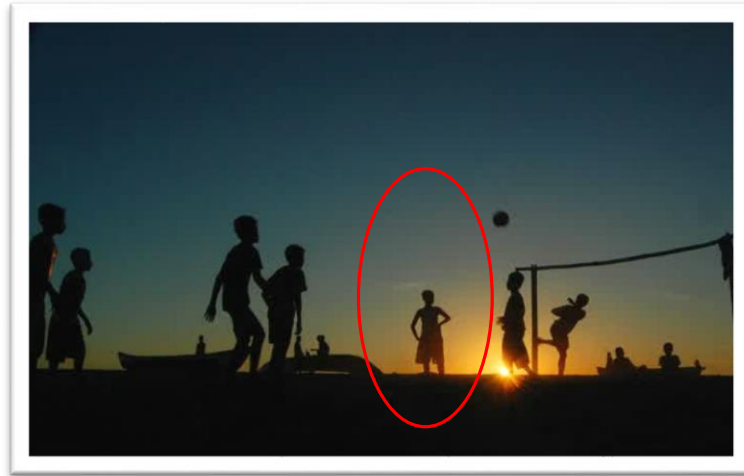
Afterward, the teacher continued the activity by emphasized student's previous answer about indicating west by seeing the sunset and conducted the activity 2.

Based on the analysis, we conclude that activity 1 is a good activity to trigger students seeing relation between cardinal directions with everything around them. This kind of activity supports the students to keep conscious with directions since they could use many things (the Sun, Masjid, the

relative systems, etc) to indicate cardinal directions. Eventhough the whole class discussion was quite short, it is very helpful to open students' mind and hear others opinion about the topic which might be never thought by themselves.

### **Activity 2: The Sun's Position and Cardinal Directions**

This activity was to introduce the students, the way to identify cardinal directions by using Sun's position. The students were given a picture of group of boys playing football when the Sun sets. Then, students were assigned to determine the cardinal directions based on the information given in one picture (see figure 4.11 and see Appendix E). There were three questions which had to be answered by students. They are as follows:



**Figure 4.11:** Picture of Problems in Activity 2, Lesson 1

*The picture was taken when the Sun set and the boy stood with his back was the Sun.*

- 1. Can you determine what cardinal direction faced by the boy?*
- 2. What cardinal directions in his left side and his right side?*
- 3. Draw a compass rose to explain your answer!*

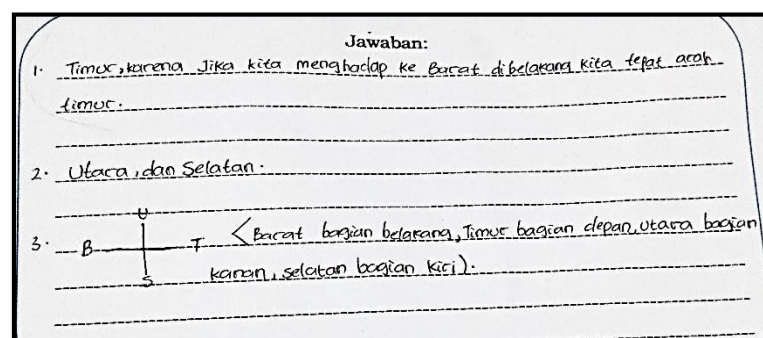
In this second activity, the students supposed to work in group. However, while explaining the problem to students, the teacher ended up discussing the problem further by explaining the way to find the answer of the three questions and brought the problem into short whole class discussion. During the discussion, the teacher asked students to determine each cardinal directions based on picture. The teacher chose one student to come forward and explain the answer. The teacher did not draw any conclusion and directly handed the worksheets to the students and asked them to work in group. Then, all students started to work on problem. In the following fragment 4.8, we shows the discussion about problems in activity 2 among students within our focus group.

**Fragment 4.8:** Discussion of Focus Group during activity 2

- 1 S\_FA : He was facing east, wasn't it? Because west was in his back (*swaying her hand to back*)
- 2 S\_FI & S\_FY : Yes, I think so.
- 3 S\_FA : (*writing the answer on the worksheet*). Then, "Explain your answer" (*read the question on worksheet*)
- 4 S\_FY : As you said, because west is in his back.
- 5 S\_FA : Okay. (*writing the answer on worksheet*). Then, number 2.
- 6 S\_FI : (*reading the question 2 aloud*) What cardinal directions in his left side and his right side?
- 7 S\_FY : It is north and south.
- 8 S\_FI & S\_FA : (*nodding*)
- 9 S\_FY : (*writing the answer*) How about question 3? I cannot make a drawing. You try to do it (*give the worksheet to S\_FI*)
- 10 S\_FI : Question 3? (*read the question*) Just draw it. (*give the worksheet back*)
- 11 S\_FY : How do I draw it? (*smiling*)
- 12 S\_FI : (*inaudible*)
- 13 S\_FA : (*draw a compass rose*)
- 14 S\_FY : Mam, how do we make the drawing for number 3?
- 15 Researcher : Because the drawing asked is based on the boy's position, then you could make something like that (*point the compass rose made by S\_FA*) and add

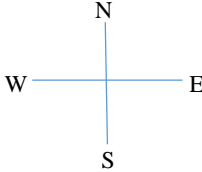
14 Students explanation in brackets. For instance, north (his left side).  
: (*nodding and continue working*)

Fragment 4.8 shows that the students in the focus group were having a hard time to give explanation for their answer. As shown in the fragment 4.8, the students actually knew the right answer. However, they did not know what kind of explanation they could give for their answer. Based on the observation in the class, we also found out that students generally had difficulties in language. Therefore, structuring sentences and chooosing words were a bit difficult for the students. We found this while during the whole implementation. Some students asked the meaning of some words. As a result, the teacher needed to explain the words in local language. Another remark was the answer of question number 2 and question number 3 (see questions in Figure 4.11). Both question are related. In spite of this, the students made mistake in answering question number 3 which was actually similar with question number 2 (see Figure 4.12).



**Translation:**

1. East, because when we face the west, east is behind us.
2. North and South
- 3.



(West is behind him, east is in front of him, north is in his right side, south is in his left side)

**Figure 4.12:** Students’ written work in Activity 2

From the fragment 4.8, the students presumably was mistaken when indicating left side and right side. It was supported by the fact we found during the wholeclass discussion. We found some students also made same mistakes as what students in the focus group did. The interesting thing is when solving the question number 3, all students in the focus group did not involve in the long discussion. They immediately agreed the answer uttered by S\_FA which was actually incorrect. Meanwhile, students answered the question number 2 correctly. In the fragment 4.8, we could see that S\_FA and other students immediately agreed the answer without any movement (moving hand or body to imagine the directions) or discussion. We considered that the students perhaps understood the question differently. Students did not see the question asked what in the left side and what in the right side orderly. Instead, students presumably thought what was asked was what the cardinal directions in each side of the boy. Therefore, their answer was actually not put in order as what in the question. We could said that order was correct coincidentally.

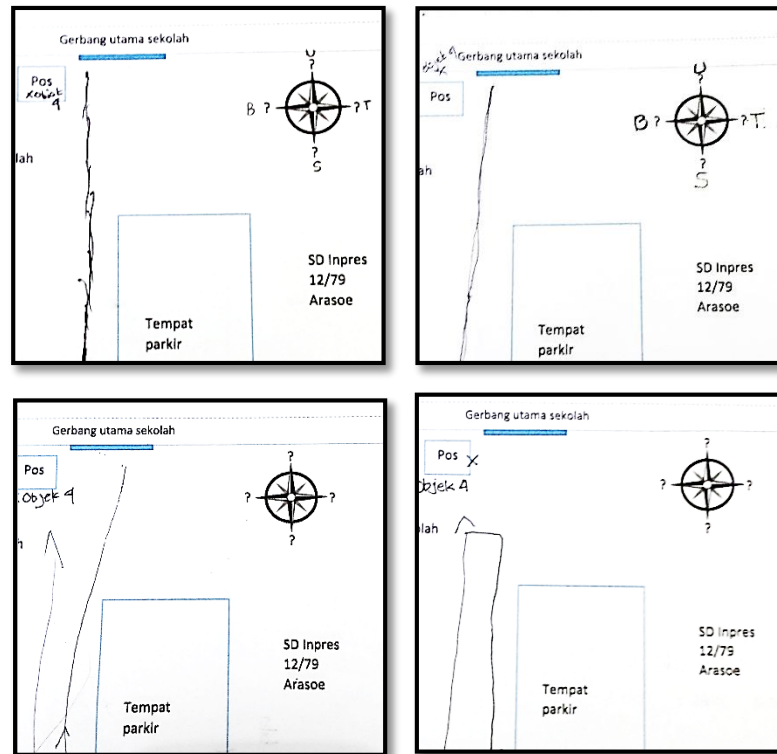
Eventhough some students made mistakes in answering the questions in the activity 2, we conclude that this kind of activity was a very meaningful

activity to support the development of students' spatial orientation. Not only making students familiar with the relation between the Sun's position and cardinal directions, but also improving their spatial orientation by using relative system.

### **Activity 3: Playing Scavenger Hunt**

The third activity was aimed to make the students to consider cardinal directions in finding location. In the activity 3, students played Scavenger Hunt in which they were assigned to find the location of five objects in the map of their school (see Appendix E). The given instruction used both cardinal directions and relative systems (see Appendix E).

Teacher started activity 3 by briefly explaining what students were going to do in the activity and handing out the worksheet. In the activity, students worked in group as what they did in the activity 2. Students read the whole instruction firstly. Afterward, students saw the map and started to find the object right away without determining the cardinal directions in the compass rose on map (see Appendix E). Teacher who were realized that while went around the class during discussion told the group to complete the compass rose firstly then finding the location of objects. In the focus group, the students complete the compass rose correctly based on the given instruction. However, some groups completed compass rose without seeing the instruction in the worksheet. The groups complete the compass rose as what the common maps have (North is in the upper part of map) or even did not complete the compass rose, as shown in the figure 4.13 below.



### Translation:

U (utara) : North  
 T (timur) : East  
 S (selatan) : South  
 B (barat) : East

**Figure 4.13:** Students' written work (completing compass rose) in Activity 3, Lesson 1

We presume this misunderstanding happened due to the lack of the emphasis on what is asked on the question as well as the emphasis on the verbal instruction by the teacher. However, we found out that the two groups manage to find the correct location of objects despite the fact that they did not complete their compass rose. One group even found all locations correctly. Therefore, we assumed that they already knew the position of each cardinal direction in their map but they merely did not write it down.

Moreover, in finding objects' location, we found that students could follow the instruction quite well. They did not find difficulties in determining cardinal directions or relative system as what we found in the first cycle. Furthermore, during the group discussion, we noticed that each group had their own preference in following the instruction on map. In the focus group, we found out that students preferred positioning the map based on the students' body (students did not turn the map into any directions while following directions in the instruction, instead the students moved their body following the directions, such as turn their body to the left or right). Meanwhile, some other groups chose to turn the map to the direction based on the instruction without turning or moving their body (they made the map follows the direction, similar with how the GPS work).

In addition, students in this cycle also encountered language problem as what we found in the cycle 1. Because formal Indonesian is their second language, students sometimes did not understand some words in the question. For instance, while working question no.3 in the activity 3 (see Appendix E), many students did not understand the word "rute" ("route" in English). As a result, the teacher explained the route in the more simple words and even explained it the local language.

The activity 3 was continued by conducting whole class discussion. As can be seen in their worksheet, many groups did quite well in finding the locations. However, the answer of the location of object 1 was quite vary.



Hereby, the fragment of whole class discussion discussing about the location of object 1.

**Fragment 4.9:** Whole class discussion in the Activity 3

- |    |         |  |
|----|---------|--|
| 1  | S_AY    | : Object 1 is (in) the classroom of grade 6. ( <i>continue explaining other objects</i> )  |
| 2  | Teacher | : ( <i>asking to other group</i> ) According to group 6's opinion? Object 1 is...  |
| 3  | S_JL    | : Object 1 is in the toilet.   |
| 4  | Teacher | : Please explain how did you get the answer? Please explain it.  |
| 5  | S_AY    | : I choose object 1 in the classroom of grade 6 because...Because we did not pass the toilet.  |
| 6  | Teacher | : ( <i>explaining to the group 6</i> ) She said because she did not pass the toilet.   |
| 7  | Teacher | : So, her answer is (in) the classroom of grade 6. What do you think, group 6? What is your reason why your answer is in the toilet?   |
| 8  | S_JL    | : Based on the instructions...   |
| 9  | Teacher | : Louder, please!  |
| 10 | S_JL    | : From your position, go out and go to the north. Then, turn right. Go straight the classroom of grade 4 is in the east of object 1 and the classroom of grade VA is in the south of object 1.   |
| 11 | Teacher | : In conclusion, they answered that object 1 is in the toilet based on the given instructions for object 1   |
| 12 | Teacher | : That's the reason why they chose that. What do you think of that, S_AY?  |
| 13 | Teacher | : Your answer is still in the classroom of 6 grade. She said that she didn't turn to the toilet's location. Instead we go straight to the classroom of grade 6. ( <i>asking group 6</i> ) What do you think, group 6? Do you agree? Or disagree?   |
| 14 | S_JL    | : No, mam.   |
| 15 | Teacher | : Later on, we will revise this.   |
| 16 | Teacher | : There were some parts that we need to revise about identifying location in map. There were some different answers. So, it is correct that object 1 is in the toilet. Because it is based on the given instruction. There is toilet behind the classroom of grade 6. Therefore, it is the location of object 1. |

As can be seen from the fragment, both groups were actually having no problem in understanding and following the instruction. The problem was

when deciding the exact location of object. Student S\_AY presumably did not consider the toilet as the location because there was class VI which was in the west of class IV (see Appendix E). She might not pay attention to the clue “*and class VA is in the south of object I*” or the student perhaps considered class VI as building in the south of class VA since she did not familiar enough with the use of “northeast”, “southeast”, “southwest”, etc. on map. In spite of this, generally the activity 3 run quite well.

Generally, we could see during the process that this activity triggered the students to apply their spatial orientation to find locations and orientate their body and their location on the map. As a result, students came up with some different strategies showing the development of their spatial orientation. Therefore, we conclude that the activity of playing *Scavenger Hunt* could support the development of students’ spatial orientation.

**c. Lesson 2: Constructing the Mental Map of Familiar Place (Map of the village in which students live)**

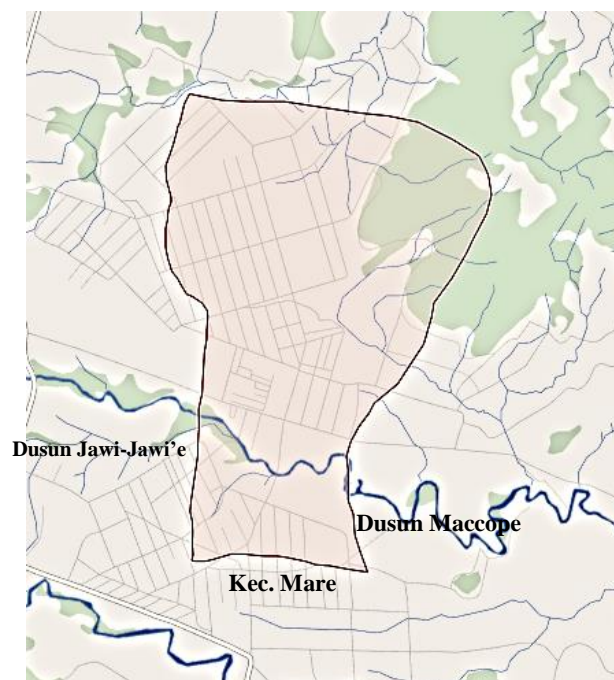
The lesson 3 consisted of two activities. Both activities aimed at developing and constructing a mental map of the village where the students live. In more details, the activities’ purpose are to help the students having general idea about the map of the village they live by identifying locations on a map with the help of cardinal directions and by applying their spatial skills.

**Activity 1: Finding Familiar Places’ Location on Map**

In this activity, students are required to use their knowledge and their experience to fill in the name of familiar places in the blank map of the village.

Students were given a blank map of their village (see Figure 4.14). As in the previous lesson, in this activity 1, students worked in group of three as well.

Teacher started the lesson asking some questions related to the village and its division (we called it “*dusun*” in Bahasa Indonesia). Based on the students’ answer when asked by the teacher, we noticed that many students were quite familiar with the division (*dusun*) of the village. Many students already knew that a village consists of some *dusun*. However, the students did not know all the name of the *dusun* in the village. They only acknowledge the *dusun* where they live and a *dusun* near from their *dusun*.



**Figure 4.14:** Map of Arasoe

The teacher acknowledge that many students did not know all the name of the *dusuns*, then she mentioned all the name of *dusuns* in the village. The teacher also discussed about some important places in the village such as

school, traditional market, the sugar factory, etc. After finishing this short discussion, the teacher showed the map of Arasoe (see Figure 4.14) and asked the students what area was depicted on the map. Most students could recognize the map of their village shown by the teacher, as a result all students answer the question correctly. Based on the lesson plan in the teacher guide (see Appendix F), teacher should hand in the worksheet and let the students find some location of places by considering the information of location of the villages nearby. However, during the process, the teacher showed the map of the village in front of the class and gave the location of some important places (*Dusun Ujung, SD Inpres 3/77 Arasoe, Pasar Traditional and Dusun Kompleks Pasar*) briefly. Afterward, the teacher gave the worksheet to the students and asked them to answer the questions.

After given the worksheet, students read the questions and took a look at the map. Because the teacher had given the location of some places, most groups marked the location of those places correctly. Moreover, teacher asked the students to find some more location of places on map. In the following fragment 4.10 shows the discussion in the focus group during the activity 1.

**Fragment 4.10: Students' group discussion in Activity 1, Lesson 2 (part 1)**

- |   |         |   |
|---|---------|---|
| 1 | S_FA    | : ( <i>write the answers on map while mumbling the name of the places</i> )                               |
| 2 | Teacher | : ( <i>approach the students</i> ) What else? How about "Masjid Makmur"? It is near our school, isn't it? |
| 3 | S_FS    | : Is "Masjid Makmur" here? ( <i>point on map</i> )  |
| 4 | S_FA    | : Isn't it too far?   |
| 5 | S_FY    | : Where is the north on this map?   |
| 6 | S_FS    | : Here. ( <i>sway her hand in the upper side of the map</i> )   |
| 7 | S_FY    | : ( <i>look at the map</i> ) How about the east?  |

- 8 S\_FS & S\_FA : Here. (*sway their hand to the right side of the map*)
- 9 S\_FY : You know, east is over there (*point to the east*). So it is here (*point a location in the right side of the location of the school on the map*), but not too far (to the right).

As shown in the fragment 4.10, the students utilize cardinal directions to indicate a location on map. Based on the knowledge they obtained in the lesson 1 (indicating cardinal directions on the map of their school), they could solve the problem in this activity.

Moreover, fragment 4.11 shows how the student solve the problems by applying their spatial orientation as well as their understanding on map reading.

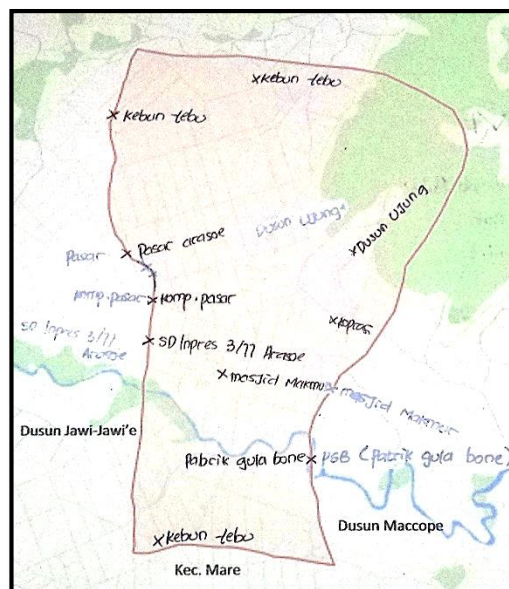
**Fragment 4.11: Students' group discussion in Activity 1, Lesson 2 (part 2)**

- 1 S\_FY : How about "PGB Arasoe" (the sugar factory)? Do you think it is here?
- 2 S\_FS : **It could be because it is near the river (*point the blue line on the map*)**
- 3 S\_FA : Yes, I think it is here (*point a location near the river and Dusun Maccopé*) because we passed it if we want to go to *dusun Maccopé*.
- 4 S\_FY : yeah, I think so. (*nodding*)
- 5 S\_FA : "Kebun tebu"(cane fields)?
- 6 S\_FY : There are so many cane fields.
- 7 S\_FA : Overhere, right? (*point on the upper side of the map*)
- 8 S\_FY : **This one is highland, isn't it? (*point the green area on the map*). So, my house is over here (*point on the area near the green area on the map*). Then, there is cane field over here (*point a location on the map*)**
- 9 Teacher : (*approach the students*). There are more cane fields. Find them. They are not only near *dusun Ujung*.
- 10 S\_FY : Yes, there are many cane fields even in the back of my house.
- 11 Teacher : You also can look the position of PGB Arasoe on map. You can use that to find the location of other cane fields too.
- 12 S\_FS : **one thing for sure, there are cane fields on the way to "Kec. Mare".**
- 13 S\_FA : Where should I put the mark?

14 S\_FS : You can put it anywhere here (*point area near the border of Arasoe and Kec. Mare*) because there are so many of them there. I've been there.

In the Fragment 4.11, we could notice that the students applied their spatial orientation to do the problems by involving their experience to find location on map (see line 14), finding landmarks or places to indicate other locations (see line 8 and line 14), utilizing cardinal directions, as well as understanding symbols on map (see line 2 and line 8).

Moreover, the following figure depicts the students' written work. If we compared it to the original map (see Appendix F), we could see that even though the location of the places were not precise, but generally the position of each place respect to each others' position was correct. we could say that the students already had the general idea about the map of their village.



**Figure 4.15:** Students' written work in the Activity 1, Lesson 2

Moreover, during the whole class discussion there was not long discussion. The students agreed the location of places given by presenter.

Based on the analysis of students' written work of each group, we also found that mostly the students had similar answer.

All in all, we conclude that the activity 1 could help the students to build general idea of the map of their village. In addition, the students also developed their spatial orientation while completing and finding location on the map in this activity because they experienced finding landmarks to indicate other locations, utilizing cardinal directions, as well as understanding symbols on maps. Therefore, we consider this activity as a meaningful activity to support the development of students' spatial orientation.

### **Activity 2: Dividing the Location of Village based on Cardinal Directions**

After conducting whole class discussion for the Activity 1, the next activity was to divide the area of village based on cardinal directions. This activity could support the students to have general picture of the village in their mind because they could easily remember the places' location with the help of cardinal directions.

The students started the activity by reading the questions. Again, students encountered language problem. Many students did not understand what "*melabeli*" means ("labelling" in English). As a result, the teacher found a simple word which have the same meaning as "*melabeli*" as well as explaining the terms in Bugis language.

Moreover, the focus group also misunderstood some part in the question 2 in the worksheet (see Appendix E). As can be seen in the following figure

4.16, there were some weird sentences written by the students. The discussion among students in the group during the activity is shown in the fragment 4.12.

Jawaban:

- Ya
- Arasoe bagian utara, kebun tebu bagian barat, Dusun Jawi-Jawi'e bagian barat, ~~dan~~ Dusun Macope bagian timur, kebun tebu bagian selatan, kebun tebu bagian utara, kebun tebu bagian barat, pasar Arasoe bagian utara.

**Translation:**

- Yes.
- North Arasoe, Kec. Mare is in the south, Dusun Jawi-Jawi'e is in the west, Dusun Macope is in the east, south cane field, north cane field, west cane field, traditional market is in the north.

**Figure 4.16:** Students' written work in Activity 2, Lesson 2

**Fragment 4.12:** Misunderstanding in the Question 2, Activity 2, Lesson 2

- |    |             |   |
|----|-------------|---|
| 1  | Teacher     | : (talking in front of the class) So you need to divide the area of the village based on the cardinal directions. For instance what is in the northern part of Arasoe.                                    |
| 2  | S_FS        | : So we write it like "traditional market" is in the northern part of Arasoe.   |
| 3  | Teacher     | : (talking in front of the class) So you divide it into four.   |
| 4  | S_FY        | : It is already given for the northern part of Arasoe. We just need to find the south, east, and west.  |
| 5  | S_FS        | : But, here (point and read the question) the northern part of Arasoe, southern part, eastern part, and western part. Okay, east. Mmm... east is over here, isn't it? (point to the left side of the map) |
| 6  | S_FY & S_FA | : Yes, east is there. (nodding)   |
| 7  | S_FS        | : South...mmm (thinking)  |
| 8  | S_FY        | : In the south is Kec. Mare. (point the bottom part of the map)   |
| 9  | S_FA        | : I think we need to find in the north first.   |
| 10 | S_FS        | : Yeah. In the north (look at the map).   |
| 11 | S_FY        | : But, what is in the north?  |
| 12 | S_FA        | : Yes, that's what I am thinking. There are nothing here.   |



- 13 S\_FY : But, you know it has been given in the question “Arasoe bagian utara” (in English “the northern part of Arasoe”)
- 14 S\_FS : (*reread the question*) “bagian utara” (in English “northern part”) comma “selatan” (in English “south”)...mmm..*(start writing)*
- 15 S\_FY : In the south is Kec. Mare
- 16 S\_FS : (*writing*)
- 17 S\_FY : and then comma.
- 18 S\_FA : what else? North, south, mmm..west. What is in the west?
- 19 S\_FY : It is *dusun* Ujung, isn’t it?
- 20 S\_FS : I think the east’s and the west’s position are reversed.
- 21 Teacher : (*approach the students and check students’ work*) Speaking in Bugis: “you need to find what is in the west, east, and so on”. (*leave the students*)
- 22 S\_FA : Oh yeah. The position of west and east were reversed.
- 23 S\_FY : yes.. yes.. They are reversed.
- 24 S\_FA : I think you should write it this way, “Kec. Mare” is in the south.
- 25 S\_FS : (*mumbling while writing*) Dusun Maccope is in the east.

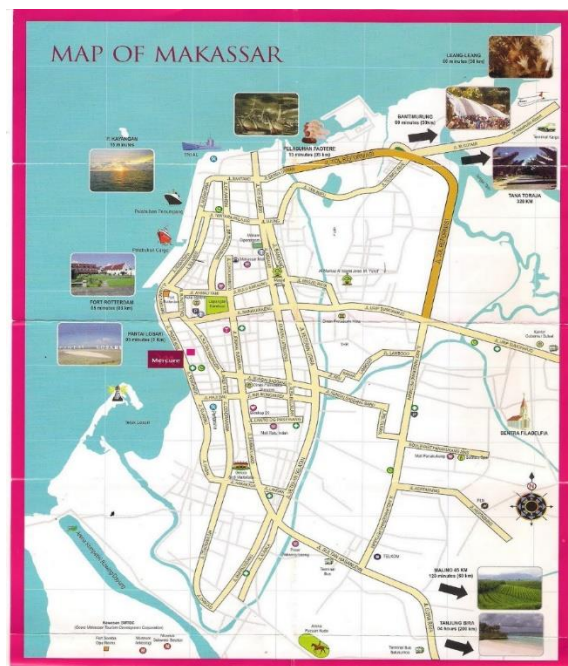
In the fragment 4.12, we could see that the students misunderstood “Arasoe bagian utara, selatan, timur, dan barat” (“the northern, the southern part, eastern part, and western part of Arasoe” in English) as in the north of Arasoe, in the south of Arasoe, in the east of Arasoe, and in the west of Arasoe. As can be seen clearly here is language is one of crucial problem encountered by the students. Therefore, the role of teacher is very important in guiding the students to understand the question while solving the problem.

However, not all students faced this kind of problem. Other groups could understand and answer the question correctly. This misunderstanding had been cleared in the whole class discussion. The group presenter explain their answer well and the teacher added explanation as well.

Therefore, based on the observation and analysis of the fragment and students' written work, we conclude that the activity 2 in the lesson 2 could help the students to imagine and have a mental map of the village they live.

**d. Lesson 3: Exploring the Map of Unfamiliar Place (Map of the City of Makassar)**

This lesson consisted of two activities. Both activities' purpose was to provide students chances to apply their spatial ability, particularly their spatial orientation by exploring map of Makassar as shown in figure 4.17. The city of Makassar is considered as unfamiliar place for the students. Even though the city is capital city of their province, the city is quite far from the village and many villagers especially the students visited this city only once or twice.



**Figure 4.17:** Map of Makassar

## Activity 1

The first activity was aimed to give a chance for students to find some locations on the map (see Figure 4.17). In this activity, students were assigned to find some locations of place on the map. The given instruction used both cardinal directions and relative systems (see Appendix E). The example of the instructions were as follows:

*... Go straight to the “Jl. Andalas”, in your left you will see a “church”. In the north of the church, you will see “Makam Diponegoro”. Go straight until you find Masjid Agung. Then, turn left to “Jl. Bulu Saraung”. Go straight to “Jl. Ahmad Yani”, “Lapangan Karebosi” is in the south of the street. ...*

Teacher started the lesson by asking students whether they visited Makassar before or no. as can be seen from students’ answer, most students had visited Makassar before. However, when asked to mention the places they knew in Makassar, many students looked flustered. Many students merely knew one famous site in Makassar which is Pantai Losari. It showed that all the students were still not familiar with the city.

In this activity, students worked in small group as in the two previous lessons. Before handing the worksheet, the teacher explained the context of the problem to the teacher (see Appendix F).

*Students in the grade 6 planned to go on study tour in three days (1 day in Makassar and 2 days in Malino). The friend of the headmaster who works in tourism office helped to make the plan by giving our school the tourist map of Makassar. Unfortunately, the given map was incomplete. Some places, sites, and street were unnamed. Then, what you are going to do was to complete the map (see figure 4.17) so the students from grade 6 could read and use the map easily.*

Teacher handed the worksheet and asked students to work on it and discuss the problem with their group. Before discussing, all group seemed busy reading and trying to understand the problem. The teacher went around the class to check students' work. She found out that many students still struggle to understand the problem. As a result, the teacher re-explained the problem, explained what students should do, and even gave an example how to do the problem. Afterward, the students seemed understand what they needed to do. The students started to complete the map of Makassar. In the following fragment 4.13, we see students' discussion to find locations on the map.

**Fragment 4.13:** Students' discussion in Activity 1, Lesson 3

- 1    S\_FY                : (*reading the instruction*) In the north of the church, you will see "Makam Diponegoro".
- 2    S\_FS&S\_FA       : (*listening and looking at the map*)
- 3    S\_FA               : (*pointing on the map*) Over here, right?
- 4    S\_FY               : Yes, I agree. That's the only thing in the north of the church.
- 5    S\_FA               : (*talking to S\_FS and pointing a location on map*) [inaudible]
- 6    S\_FY               : Write it. Makam Diponegoro.
- 7    S\_FA               : (*writing on the map*)
- 8    S\_FY               : (*continue reading the instruction*) Go straight until you find "Masjid Agung"
- 9    S\_FS&S\_FA       : (*listening and looking at the map*)
- 10   S\_FS               : (*pointing the location of Masjid Agung on the map*) Here.
- 11   S\_FY               : Then, turn right to "Jl. Bulu Saraung".
- 12   S\_FA               : (*turn her body to left following the direction*) Ah...this way. (*writing the answer*)

The fragment 4.13 showed how the students in the focus group worked on the problem. We could see that the students came up with body moving strategy to imagine themselves walking on the map, especially when following instruction which involved relative system. In addition, students seemed having

no problem when following instruction with cardinal directions in it. They could easily determine the north, east, south, and east without constantly checking the compass rose. While doing the activity, we also noticed that other groups had their own preferences to orientate themselves on map to find locations asked. Fragment 4.14 shows the strategy used by other groups.

**Fragment 4.14:** Other Groups' strategy in solving problem in Activity 1, Lesson 3

**Group 2**

- |   |          |  |
|---|----------|--|
| 1 | S_MN     | : Let's reread the instruction.  |
| 2 | S_YS     | : In the northern side of the street, you can see "Pelabuhan Paotere". Then, you will see the cross road, turn left to "Jl. Yos Sudarso" |
| 3 | S_HL     | : <i>(pointing a location on map)</i> This one...  |
| 4 | S_MN     | : <i>(pointing the same location on map)</i> It must be here.  |
| 5 | Students | : Yes. Yes... Write it down. Write it down   |
| 6 | S_HL     | : <i>(writing on the map)</i>  |
| 6 | S_YS     | : Because we stand this way <i>(turn his body to the east)</i> and north is in this side <i>(turn his face to the north)</i>             |

**Group 3**

- |   |      |  |
|---|------|--|
| 1 | S_AY | : Go straight to Tol Reformasi, in the northern side of the street... North... <i>(turn the map to another direction so she could follow the street)</i> You can see the "Pelabuhan Paotere". Mmm... <i>(Thinking)</i> |
| 2 | S_DN | : Here <i>(point a location on map)</i>  |
| 3 | S_AY | : Here <i>(point a location on map)</i> . Mmmm... No. Or here? <i>(point another location)</i>   |

Fragment 4.14 shows that some other group also came up with some strategy to complete their map based on the instruction. Group 2 preferred moving their body. However, group 2 did not use this strategy to follow instruction in relative system as what the focus group did, instead they used their body to memorize the position of each cardinal directions. Moreover, group 3 had different strategy with the other two groups. Instead of using their

body, students moved and turned the map to the directions in the instruction. So, the students turned the map to the direction mentioned as what we have in GPS. Generally, we could see that this kind of problem triggered many different strategies from the students.

**Fragment 4.15:** Problem encountered by students in Activity 1, Lesson 3

- 1    S\_NL                : *(reading the instruction)* Go straight until “Masjid Agung”. Then turn right to “Jl. Bulu Saraung”.
- 2    S\_RZ                : *(looking at the map)* Bulu Saraung? Where is it? Where is it? Where is it that? Ah... This must be wrong. Bulu Saraung? Where is it?
- 3    Researcher        : Look at the instruction carefully. From Masjid Agung...Read it, please?
- 4    Researcher        : *(reading the instruction)* Go straight until “Masjid Agung”. Where is Masjid Agung?
- 5    Students            : Here *(pointing the location fo Masjid Agung on the map)*.
- 6    Researcher        : From what direction do you walk? From this direction, right? *(pointing on the map)* Where is your right side then if you walk from that side? Where is your right side then?
- 7    S\_RZ                : Here *(pointing the left side of the street on the map)*.
- 8    S\_SL                : No. We stand this way *(standing and turning his body to the opposite direction of other students' seats' position )*
- 9    Researcher        : You stand that way. Because you walk from that side *(pointing on the map)*. Where is your right side then?
- 10   S\_RZ                : Here *(pointing the right side of the street on the map and smiling)*.
- 11   S\_RZ                : *(writing the answer on the map)*

As can be seen from the fragment 4.15, while doing the activity, some students also faced problem in the relative system. Because not all students had strategy to orientate their body, some of them made mistakes in determining left and the right side on the map. The students merely imagined their movement on the map (they did not move their body or turn the map following

the directions mentioned). As a result, they sometimes made mistakes as what is shown in the fragment 4.15.

Based on the analysis, we conclude that this activity is a good activity to support the development of students' spatial orientation. It provided students an opportunity to experience map using and map reading which triggered students to understand that symbols on map representing things in the space. Moreover, students could identify the some different reference points while identifying locations. Students could get the idea that what kind of reference points they could use when using cardinal directions and relative system.

## **Activity 2**

This activity offered students an opportunity to arrange a plan go around Makassar in a day. They need to consider the important things, such as the attraction, Musholla, place to have lunch, etc. Therefore, they needed to make sense all information on map and planned a scenario for that. In this activity, students were required to apply their spatial orientation to find the solution.

Teacher started this activity by handing the worksheet to each group. Afterward, teacher explained what students should do in this activity. Students then read the questions and instruction in the worksheet. While doing this activity, the students looked excited since they had freedom to make their own itinerary. Each group did choose the places visited carefully based on their preferences. The following fragment 4.16 shows students' discussion in making their itinerary.

**Fragment 4.16:** Discussion in the focus group in Activity 2, Lesson 3

- 1 S\_FA : We need to go to Masjid to pray.
- 2 S\_FS : Yes, I agree with you.
- 3 S\_FY : We also need to have lunch.
- 4 S\_FS : Let's go to Pantai Losari too.
- 5 S\_FY : What do you think, S\_FA? We are going to Pantai Losari.
- 6 S\_FA : Okay. That's good.
- 7 S\_FY : We could just have lunch in the restaurant near Pantai Losari.
- 8 S\_FS : How about Masjid? Which Masjid will we visit?
- 9 S\_FA : Masjid 01 is okay (*pointing the location of Masjid 01 on map*)
- 10 S\_FS : But, we are from Bone.
- 11 S\_FY : That's okay.
- 12 S\_FA : (*writing on the worksheet*) So, from Pantai Losari, where will we go?
- 13 S\_FY : (*looking at the map*) Oh... I think it's better if we go to Masjid Agung. So afterward, we could directly go to Pantai Losari
- 14 S\_FA&S\_FS : (*looking at the map*) Mmm... Okay.

Fragment 4.16 shows that students chose the place they want to visit carefully. They considered the attractiveness of the place as well as the route they were going to take. It shows that students apply their spatial skills in making their decision in their itinerary. However, there were some groups who did not do as what students in the focus group did. The fragment 4.17 shows a group who did not consider the distance and the route while making their itinerary.

**Fragment 4.17:** Students' group discussion in Activity 2, Lesson 3

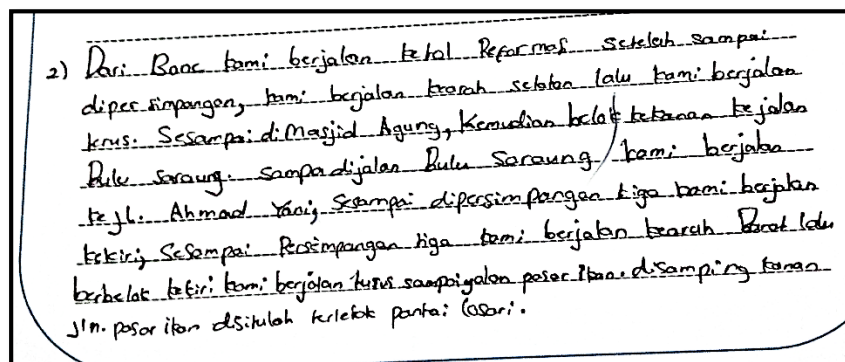
- 1 Researcher : Are you done?
- 2 S\_RZ : Yes.
- 3 Researcher : May I see it?
- 4 S\_NL : (*showing the worksheet*)
- 5 Researcher : Have you check your route?
- 6 S\_RZ&S\_SL : Pardon?



- 7 Researcher : May I see the map? Okay. Let me see you choice of places. Okay, imagine yourselves walk on the map. What is your first destination?
- 8 S\_RZ : *(holding the map)*
- 9 Students : *(looking at the map)*
- 10 S\_RZ : Pantai Losari.
- 11 Researcher : Okay. Check it on map. After Losari, what is your next destination?
- 12 S\_RZ : Masjid Agung
- 13 Students : *(looking at the map)*
- 14 S\_SL : Gee... It's too far *(pointing the location of Masjid Agung on map)*
- 15 Researcher : Okay, think of it.
- 16 S\_SL : *(smiling and looking at other students)*
- 17 S\_RZ&S\_NL : Let's try this *(pointing a route on the map)*

As can be seen from fragment 4.16, some students at first did not consider the route they took. They merely thought of interesting places to visit. In fact, considering the route and distance they took is the main idea of this activity because thinking about route and distance could trigger students to apply their spatial skills in making their decision. Therefore, after finding same problems as in the fragment 4.16, teacher re-explained the question and told the students to be careful in choosing places. Afterward, many students checked their work and revised them.

Other thing that we noticed in this activity is the improvement of students' language in giving direction. Even though, there were some sentences which sound a bit strange, generally the use of spatial orientation terms of the students improved a lot. In the beginning of the lesson, most students only use relative system in describing locations and directions. However, in this last lesson, many students already could describe a location and give directions with proper and understandable way. It can be seen in the following figure.



### **Translation:**

From Bone, we go to Tol Reformasi, after the cross road, we go to the south and go straight. Arriving in Masjid Agung, we turn right and go to Jl. Bulu Saraung. After going to Jl. Bulu Saraung, we go to Jl Ahmad Yani. After in the T-junction, we turn left. After the T-junction, we go to the west and turn left. We go straight to Jl. Pasar Ikan. In the right side of Jl. Pasar Ikan, we arrive at Pantai Losari.

**Figure 4.18:** Students' written work in Activity 2, Lesson 3

Based on the analysis, Activity 2 in this lesson is considered as a good activity to support the development of students' spatial orientation. Each task in the activity could give positive effect to the students' spatial ability. Question 1 (see Appendix E) could trigger students to apply their spatial skills in making their decision since they have to consider distance, route, and location in planning their itinerary. Meanwhile, question 2 supports students' spatial language because it forces students to explain location and giving direction clearly to make other people understand them.

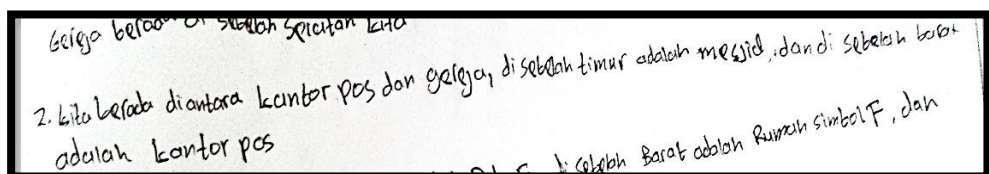
### **e. Post-test**

The post test was conducted after the three meetings. It involved 24 students, since one of the students was absent. The purpose of this post-test was to clarify the students' knowledge development that had been observed and analysed in the teaching experiment phase. The problems were a bit different

from which in the pre-test. However, the problems given in the post test still have similar aims as what we had in the pre-test.

Generally, we integrated the five purposes as what we had in the pre-test (see Table 4.3) into the 8 items in the post-test (see Appendix D).

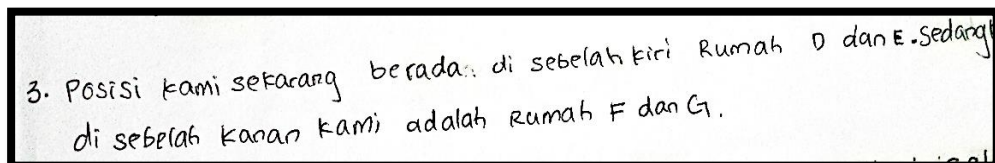
Based on the analysis of the result of the post –test, we noticed that many students had developed their spatial orientation. 16 out of 24 students answered question 1, question 2, and question 3 correctly. Meanwhile, for question 4, it had been answered correctly by all students. In the following figure 4.19, it is shown that most students improved their language and accuracy in following instructions (using both cardinal directions and relative systems) and describing locations.



Geleja berada di sebelah Selatan kita  
2. Kita berada diantara Kantor pos dan Geleja, di sebelah timur adalah mesjid, dan di sebelah barat adalah Kantor pos

**Translation:**

We are in the middle of “Kantor Pos” and “Church”, in the east of us is “Masjid” (he might mean Church) and in the west of us is “Kantor Pos”.



3. Posisi kami sekarang berada di sebelah kiri Rumah D dan E. Sedangkan di sebelah kanan kami adalah Rumah F dan G.

**Translation:**

Our position is in the left side of “Rumah D” and “Rumah E” and in our right side is “Rumah F” and “Rumah E”.



**Translation:**

My position is facing the south, in my right side is “Kantor Pos” and in my left side is “Masjid”.

**Figure 4.19:** Students’ written work in the post-test

After the post-test, we conducted an interview with the students in the focus group. Basically, the interview was about the way students solved and answered the 8 questions in the post-test. Based on the result of the interview, we concluded that the three students developed their own strategy in orientating themselves on the map. From the interview, we could see they easily followed the instructions and explained locations quite well. We did not find any mistakes in making compass rose anymore as we found in the pre-test. In the pre-test, the students tended to merely use relative systems. However, during the interview, they also utilized cardinal directions in describing position and location accurately.

Moreover, many students become more familiar with their village as well as the map of village. From the students’ answer of question 5 until question 8, we could see that most students knew the map of their village quite well. For question 5, 18 out of 24 students answered the question correctly. Meanwhile, question 6 had been answered correctly by 17 students. Lastly, 20 out of 24 students answered question 7 and question 8 correctly.

Based on the result of the post-test, students were able to answer the questions in the post-test quite well. Therefore, we derive conclusion that most

students had developed their spatial orientation as what was also shown during the three lessons during the teaching experiment.

#### **f. Discussion and Conclusion of the Teaching Experiment**

##### **1) The Development of Students' Spatial Orientation**

As said by Clarke (2003), the map reading ability was divided into four component, which are: (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. These four component were integrated in the activities of each lesson.

Based on the analysis of each lesson, we made an outline of important issues related to the activities as follows:

##### **Lesson 1**

In the first activity, many students participated during the discussion. The discussion triggered students seeing relation between cardinal directions with everything around them. This kind of activity supports the students to keep conscious with directions since they could use many things (the Sun, Masjid, the relative systems, etc.) to indicate cardinal directions. Even though discussion was short, it is very helpful to open students' mind and hear others opinion about the idea which might be never thought by themselves.

Meanwhile, in the Activity 2, the teacher looked a bit flustered in the some parts of the activity. She did not emphasis more in the important point

of the problem. As a result some students made mistake in answering the question . however, based on the analysis we could we conclude that this kind of activity was a very meaningful activity to support the development of students' spatial orientation. Not only making students familiar with the relation between the Sun's position and cardinal directions, but also improving their spatial orientation by using relative system in answering the question.

In the last activity of the lesson, many students started to develop their spatial orientation by finding location of objects on the map as well as orientating their body and their location on the map. Students came up with some different strategies showing the development of their spatial orientation. Therefore, we conclude that the activity of playing Scavenger Hunt could support the development of students' spatial orientation.

## Lesson 2

Activity 1 supported the students to construct the map of their village by completing the blank map of the village with the help of cardinal directions. The students experienced finding landmarks to indicate other locations, utilizing cardinal directions, as well as understanding symbols and all information on maps. Therefore, we consider this activity as a meaningful activity to support the development of students' spatial orientation.

Moreover, in the activity 2, we saw students' preferences were different in dividing the area of the village. Because the dividing it by considering cardinal directions, it could help them to remember the location

of important places in the village. As a result, they could construct the mental map of the village. It is shown in the result of the post-test, many students did not have any difficulties anymore in answering question related to location of places on the map of their village.

### Lesson 3

First activity in this lesson is considered a good activity to support the development of students' spatial orientation. Within this activity, students experienced using and reading map with larger scale than the map of the village. We could see that the activity triggered students to understand that symbols on map representing things in the space. We could see many students understood the meaning symbols on the map quite well during their group discussion. Moreover, students could identify the some different reference points while identifying locations. Students could get the idea that what kind of reference points they could use when using cardinal directions and relative system.

Moreover, Activity 2 in this lesson is considered as a good activity to support the development of students' spatial orientation. The task in the activity could give positive effect to the students' spatial ability. It triggered students to apply their spatial skills in making their decision since they have to consider distance, route, and location in planning their itinerary. In whole class discussion, students uttered how their decision made. As Clements and Sarama (2009) said that spatial orientation is the ability to know and comprehend the relationships between different positions in space with

respect to our own position and our movement through it. Moreover, task to giving directions in the activity also developed students' spatial language because it forces students to explain location and giving direction clearly to make other people understand them.

Generally, activities and the respond of the students during the lesson were in line with what we predicted in the HLT. In the table 4.4, we presents the Dierdrop's matrix analysis of the teaching experiment. The matrix shows the comparison between what happened in the actual learning process with the predictions we made in the HLT.

**Table 4.4:** Matrix analysis of the teaching experiment

Lesson	Activity	HLT	ALT
Lesson 1	Discussion of general idea of cardinal direction.	<ul style="list-style-type: none"> <li>• Students utter the idea of using the Sun's position</li> <li>• Students come up with the idea using Masjid and Qibla</li> </ul>	<ul style="list-style-type: none"> <li>• Students uttered the idea of determining cardinal directions by seeing where the Sun rises.</li> <li>• Students used Qibla to determine the west and use relative system for determining the other cardinal directions</li> </ul>
	Using Sun's position to determine cardinal directions	Students use relative system to help them determine the position of each	Students used relative system to help them memorize the position of each cardinal



Lesson	Activity	HLT	ALT
		cardinal directions	directions in compass rose or in the real situation.
	Playing Scavenger Hunt (finding objects on the map of school)	<ul style="list-style-type: none"> <li>• Students apply their spatial orientation to find location</li> <li>• Some students move their body to orientate their position on the map</li> <li>• Some students turn the map to asked directions.</li> <li>• Some students do a mental movement in their head</li> </ul>	<ul style="list-style-type: none"> <li>• Students applied their spatial orientation by following the instruction to find the location of the objects</li> <li>• Students came up with some different strategies to orientate themselves on the map, some of them preferred the strategy of moving body, turning map, or merely a mental movement in their head which was sometimes made them confused and make mistakes</li> </ul>
Lesson 2	Finding location of familiar places on the map of the village where the students live	<ul style="list-style-type: none"> <li>• Students find some locations based on the position of other nearby village</li> <li>• Student use their previous knowledge of cardinal</li> </ul>	<ul style="list-style-type: none"> <li>• Students found some locations of places on the map based on the position of other nearby village, symbols on the map such</li> </ul>

Lesson	Activity	HLT	ALT
		<p>directions in the school area to determine places location on the map</p>	<p>as high land and river.</p> <ul style="list-style-type: none"> <li>• Student found the location of places near the the school and used their previous knowledge of cardinal directions in the school area to determine places' location and position respect to school's position.</li> </ul>
	Dividing the area of the village based on cardinal directions	<ul style="list-style-type: none"> <li>• Students divide the area based on their preference</li> <li>• Students construct their mental map by remembering the list of places in each cardinal directions</li> </ul>	<ul style="list-style-type: none"> <li>• Students divided the area based on their preference</li> <li>• Students constructed their mental map by remembering the list of places in each cardinal directions</li> </ul>
Lesson 3	Completing the map of unfamiliar place based on the instructions.	<ul style="list-style-type: none"> <li>• Students apply their spatial orientation to complete the map based on the given instruction using cardinal directions and relative system</li> <li>• Students apply the strategy they</li> </ul>	<ul style="list-style-type: none"> <li>• Students applied their spatial orientation to complete the map based on the given instruction</li> <li>• Students did not face difficulties in following the instruction</li> </ul>

Lesson	Activity	HLT	ALT
		used in the lesson 1	using cardinal directions and relative system <ul style="list-style-type: none"> <li>Students applied same strategy as they used in the lesson 1</li> </ul>
	Making an itinerary for spending 1 day in Makassar	Students apply their spatial skills to make decision in their itinerary.	Students considered distance, simplicity of route, time consumption, and the attractiveness of places in making decision in their itinerary, such as what places to be visited, the route will be take, etc.

## 2) Social Norms and Socio-Mathematical Norms

Regarding the social norms in the class, this classroom was very silent, especially in the first lesson. It was presumably due to the classroom culture formed by teacher in the past. Many students seemed afraid to talk aloud even when discussing in the groups. However, during the lesson teacher were trying hard to involve students during the process, by asking question. We noticed that the students have no confidence to utter their opinion because they were afraid to make mistakes. However, there were improvement in the lesson 2 and the lesson 3. During the group discussion, the students started to talk a bit louder. In the whole class discussion, many students started to have confidence in uttering their idea and opinion as

well. Moreover, students worked well in group so generally. They did shared idea within their group members and communicate opinion well.

The other concern was the socio-mathematical norms. It was shown that the activities in each lesson triggered students to perform reasoning for their solution. At first, students was a bit unsure and uneasy if asked their explanation, eventually in the last lesson the students could describe their answers quite well.

### 3) The Teacher's Role

The teacher played important roles in this study. Based on the observation, the teacher's role during the implementation were quite well. Even though sometimes the teacher looked flustered or forgot what to do, generally she did quite well in handling the class and teaching the material. She understood all problems in the lesson quite well. However, there were some moments in which the teacher did not respond students' questions or answers properly. As a result, some discussion ended up with vague answer. Generally, the teacher's role during the lesson was very helpful, but it still needed to be optimized in some parts.

## **CHAPTER V**

### **CONCLUSION AND SUGGESTION**

In this chapter, we will discuss 3 important issues which are conclusion section, weakness and limitation of the study section, and suggestion section. In the conclusion section, we answer the research question and present the local instruction theory on supporting the development of students' spatial orientation. Meanwhile in the suggestion section, we give suggestion and recommendation for further study including the important remarks from the whole learning sequence of the design. In the weakness and limitation of the study section, we present some interesting remarks which should be administered properly for better result.

#### **A. Conclusion**

*“How can the use of cardinal directions in map reading activities support the development of students' spatial orientation?”*

Based on the retrospective analysis, we derived a conclusion that the use of cardinal directions in map reading activity could support the development of students' spatial orientation.

In this study, we designed the learning sequence (learning trajectories) about map reading that is aimed to contribute the local instruction theory of spatial orientation in map reading. We explain briefly how cardinal directions in map reading activities support the development of spatial orientation each activity as follows:

1) Short discussion about cardinal directions.

The activity supports students seeing relation between cardinal directions with everything around them. It could help the students to keep conscious with directions since they could use many things around them (the Sun, Masjid, the relative systems, etc.) to indicate cardinal directions.

2) Finding cardinal directions with the help of the Sun's position

This activity could support the development of students' spatial orientation. When indicating the cardinal directions, students could apply relative systems to orientate their body based on the given situation in the problem. The activity also could helped the students to be more familiar with the position of each cardinal direction in the compass rose.

3) Finding several objects' location on the map of school

The activity could support the development of students' spatial orientation. It triggered the students to apply their spatial orientation to find locations and orientate their body and their location on the map. The activity supported students to find some different strategies of orientating their body on a map.

4) Finding familiar places' location in the blank map of the village

The activity could support the development of students' spatial orientation when the students constructed general idea of the map of their village. The students could develop their spatial orientation while completing and finding location on the map in this activity because they could experience finding landmarks to indicate other locations, utilizing cardinal directions to indicate

locations, considering others' location as reference points to find locations , as well as understanding symbols on maps.

5) Dividing the village based on cardinal direction

The activity could support the development of students' spatial orientation by helping the students to construct a mental map of a familiar place with the support of cardinal directions.

6) Completing a map by finding locations based on the given instruction

This activity is a good activity to support the development of students' spatial orientation. It provided students an opportunity to experience map using and map reading which triggered students to understand that symbols on map representing things in the space. Moreover, students could identify the some different reference points while identifying locations. Students could get the idea that what kind of reference points they could use when using cardinal directions and relative system

7) Making an itinerary

This activity could trigger students to apply their spatial skills in making their decision since they have to consider distance, route, and location in planning their itinerary. Moreover, it also could improve students' spatial language because it forces students to explain location and giving direction clearly to make other people understand them. Therefore, this kind of activity could support the development of students' spatial orientation.

Eventually, students need the spatial orientation in learning mathematics. Be involved in several map reading activities could help the students to enhance their

spatial orientation and spatial ability in general. During these kind of activity, we could support students to grasp the idea of identification the object, location, position, and direction. We should pay more attention in this field. We need to stimulate and facilitate to expand this ability.

**Table 5.1:** Local Instruction Theory on Supporting the Development of Students' Spatial Orientation

<b>Context</b>	<b>Tools</b>	<b>Activity</b>	<b>Ability</b>
Where is the north?	-	Short discussion about cardinal directions.	<ul style="list-style-type: none"> <li>• Preliminary knowledge about cardinal directions</li> <li>• Recognizing surroundings which could help to orientate ourselves using cardinal directions</li> </ul>
Taking picture while the Sun sets	Picture of sunset or sunrise	Finding cardinal directions with the help of Sun's position	<ul style="list-style-type: none"> <li>• Understanding the relation between Sun's position and cardinal directions</li> <li>• Supporting student spatial orientation by involving relative systems and cardinal direction to help students orientate themselves</li> </ul>
Playing Scavenger Hunt	Map of the school	Finding several objects' location on the map of school	<ul style="list-style-type: none"> <li>• Supporting students' spatial orientation by finding locations and following routes</li> <li>• Supporting students' spatial language by understanding instruction of direction in two systems (relative</li> </ul>



Context	Tools	Activity	Ability
			systems and cardinal directions)
Exploring map of Arasoe	Map of the village where students live	Finding familiar places' location in the blank map of the village	<ul style="list-style-type: none"> <li>Supporting spatial orientation of the students by constructing their own mental map of a familiar place</li> </ul>
		Dividing the village based on cardinal direction	
Exploring the map of Makassar for preparing a study tour	Map of unfamiliar place	Completing the map by finding locations based on the given instruction	<ul style="list-style-type: none"> <li>Supporting students' spatial orientation by finding locations and following routes in a larger scale of map</li> <li>Supporting the students' map reading ability</li> </ul>
		Making an itinerary for the study tour	<ul style="list-style-type: none"> <li>Supporting students' spatial language by giving a chance to give direction and describe location of places using relative systems and cardinal directions</li> </ul>

## B. Weaknesses of the Study

During the study, we faced some obstacles and limitation that cannot be avoided. We gather them and called them as the weaknesses of the study. They are as follows:

### 1) Social norms and Socio-mathematical norms in the class

Some aspects of social norms and socio mathematical norms we wanted to develop in the study were quite different from what the class already had. The

students somehow were not familiar enough with the idea of explaining the reason or an answer. As a result, we found it hard to know students' real thinking. Moreover, the teacher we involved in this study have no experience about PMRI. She was also not accustomed to organize a whole class discussion as what we planned. She seemed confused how to propose a guiding question to the students. As a result, several norms that used to be in the traditional teaching method were still exist during the learning process.

2) Language problem

Since formal Bahasa Indonesia is their second language, we faced some language problem. Some students did not understand the two or more words in the question.

3) Students' learning style

We did not conduct a formal test to classify students' learning style, instead we merely made assumption about the learning style of students in elementary school in general. Therefore, it might affect the accuracy of students' learning trajectory.

### **C. Suggestion**

Based on the conclusion and the weaknesses of the study, we have some suggestions as follows.

1. Considering social norms and socio mathematical norms issue, the important roles of the teacher cannot be ignored. The establishment of social norms and socio-mathematical norms in the certain classroom takes time.

We suggested that for the next researcher to have a very clear and detail

teacher guide to help the teacher more in implementing the design and establish the social norms and socio mathematical norms we want. Having a discussion or meeting about the PMRI especially the social norms and the socio mathematical norms with the teacher to help the teacher to understand our design.

2. The next researchers also need to consider the language of the students. Using more simple and short words as well as clear sentences is a good way to avoid students' misunderstanding towards the question and instructions.

## REFERENCES

- Bishop, J A. (1980). Spatial Abilities and Mathematics Education- A Review. *Educational Studies in Mathematics*. Vol. II. 257-269.
- Boroditsky, L. 2011. How Language Shapes Thought. The languages we speak affect our perceptions of the world. *Scientific American*. Retrieved from <http://www.gwashingtonhs.org/ourpages/auto/2013/10/23/68598699/sci-am-2011.pdf>. (Accessed on August 11, 2014)
- 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, DH. (1998). *Geometric and Spatial Thinking of Young Children*. National Science Foundation, Arlington, VA.
- Clements, D.H. & Sarama, J. (2009). *Learning and teaching early math: The learning trajectories approach*. New York: Routledge.
- Diezmann, C. M., & Lowrie, T. (2008). An instrument for Assessing Primary Children's Knowledge of information Graphics in Mathematics. *Assessment in Education: Principle, Policy & Practice*, 16:2, 131-147.
- Edelson, D.C. (2002). Design Research: What We Learn When We Engage in Design. *The Journal of the Learning Sciences*, 11(1), 105–121.
- Fosnot, C. T., & Dolk, M. (2001). *Young mathematicians at work: constructing number sense, addition, and subtraction*. Portsmouth, NH: Heinemann.
- Gravemeijer, K. (1999). How emergent models may foster the constitution of formal mathematics. *Mathematics Thinking and Learning*, I(2), 155-177.
- Gravemeijer, K., & Cobb, P. (2006). Design research from the learning design perspective. In Van den Akker, J., Gravemeijer, K., McKenney, S., & Nieveen, N (Eds.), *Educational design research*. London: Routledge.
- Gravemeijer, K. (2009). *Local Instruction Theories as Means of Support for Teachers in Reform Mathematics Education*.
- Gyanchandani, R. (2013). A Study on Learning Style of Students of B-School. *International Journal of Entrepreneurship & Business Environment Perspectives*. Vol. 2(2), ISSN (P):2279-0918, (O):2279-0926.

- Holbrook, Jarita C. (2012). Globalization in Bugis History: *Celestial Navigation and Technological Change on Moce Island*. Berlin: Epubli.
- Kurniadi, E. (2013). *Design Research in Mathematics Education: Map Reading Supports the Development of Spatial Ability*. A Thesis. Faculty of Teacher Training and Education, Sriwijaya University.
- Lehning, M, Leplow, B, Friege, L, Herzog, A, and Ferstl, R. (1998). Development of Spatial Memory and Spatial Orientation in Pre-schoolers and Primary School Children. *British Journal of Psychology*. Vol. 89, 463-480.
- Leite, Walter L., Svinicki, Marilla, & Shi, Yuying. (2010). Attempted Validation of the Scores of the VARK: Learning Styles Inventory With Multitrait–Multimethod Confirmatory Factor Analysis Models. *Educational and Psychological Measurement, SAGE Publications*. Vol. 70(2) 323–339.
- Levinson, S C. (2003). *Space in Language and Cognition: Explorations in cognitive diversity*. Cambridge University Press: Cambridge.
- Liebner, Horst H. (2005). Indigenous concepts of orientation of South Sulawesi sailors. *Bijdragen tot de Taal, Land-en Volkenkunde (BKI)*, Vol. 161-2/3, 269-317.
- Lord, FE. (1941). A Study of Spatial Orientation of Children. *The Journal of Educational Research*. Vol. 34, No. 34. pp 481-505.
- Lowrie, T. (2010). *Primary students decoding mathematics tasks: The role of spatial reasoning*. Research Conference.
- Lowrie, T and Logan, T. (2006). Using Spatial Skills to Interpret Maps, Problem Solving in Realistic Contexts. *Australian Primary Mathematics Classroom* 12 (4), 14-19.
- National Research Council. (2006). *Learning to think spatially: GIS as a support system in the K—12 curriculum*. Washington DC: National Academy Press.
- Risma, D.A. (2013). *Spatial Visualization and Spatial Orientation Tasks to Support the Development of Students' Spatial Ability*. A thesis.
- Simon J Catling. (1978): The Child's Spatial Conception and Geographic Education. *Journal of Geography*. Vol. 1 No. 77, 24-8.
- Simon, M. A. (1995). Reconstructing mathematics pedagogy from a constructivist perspective. *Journal for Research in Mathematics Education*, 26, 114-145.
- TAL team (2006): TALboek.
- Thorndyke, PW and Hayes-Roth, B. (1982). Differences in Spatial Knowledge Acquired from Maps and Navigation. *Cognitive Psychology*. Vol. 14, 560-589.

- Van den Heuvel-Panhuizen, M. (2003). The Didactical Use of Models in Realistic Mathematics Education: An Example from A Longitudinal Trajectory on Percentage. *Educational Studies in Mathematics*, 54: 9–35.
- Van den Akker, J., Gravemeijer, K., McKenney, S., & Nieveen, N. (Eds.). (2006). *Educational design research*. Taylor & Francis.
- Van Eerde, H. A. A. (2013). Design Research: Looking into the heart of mathematics education. *Proceeding of the 1<sup>st</sup> SEA-DR*
- Wasilah, Prijotomo, J, Rachmawaty, M. (2010). *Application of Topophilia Concepts in the Architecture of the Bugis House*. Retrieve from [http://www.researchgate.net/publication/259231161\\_Full\\_Paper-KALAM](http://www.researchgate.net/publication/259231161_Full_Paper-KALAM) (Accessed on February 24, 2015)
- Zulkardi, Z. (2002). *Developing A Learning Environment on Realistic Mathematics Education for Indonesian Students and Teachers*. University of Twente.

## **APPENDICES**

# **APPENDICES:**

**Appendix A: Learning Line of the teaching experiment**

**Appendix B: Teacher's Interview Scheme**

**Appendix C: Classroom Observation Scheme**

**Appendix D: Pre-test and Post-test (Cycle 1 and Cycle 2)**

**Appendix E: Students' Worksheets (Cycle 1 and Cycle 2)**

**Appendix F: Teacher Guide (Cycle 1 and Cycle 2)**

**Appendix G: The Improved HLT used in Cycle 2**



## LEARNING LINE OF THE TEACHING EXPERIMENT

Lesson	Context	Main Idea	Students' Activities
Lesson 1	Playing Scavenger Hunt	To supports students seeing relation between cardinal directions with everything around them.	1) Short discussion about cardinal directions.
		To make students familiar with the relation between the Sun's position and cardinal directions, but also improving their spatial orientation by using relative system.	2) Finding cardinal directions with the help of Sun's position
		To support students applying their spatial orientation to find locations and orientate their body and their location on the map.	3) Finding several objects' location on the map of school
Lesson 2	Completing the Map of Arasoe	To help the students to build general idea of the map of a familiar place by experiencing finding landmarks, using landmarks and cardinal directions to indicate locations as well as understanding symbols on maps.	1) Finding familiar places' location in the blank map of the village
		To support the development of students' spatial orientation by helping the students to imagine and have a mental map of the village they live.	2) Dividing the village based on cardinal direction

Lesson	Context	Main Idea	Students' Activities
Lesson 3	Completing Map of Makassar for A Study Tour	To provide students an opportunity to experience map using and map reading of an unfamiliar place	1) Completing a map by finding locations based on the given instruction
		To support the students to apply their spatial skills in making decisions and to improve students' spatial language	2) Making an itinerary

### Interview with the Teacher

1. Background of the teacher
  - a. How long do you become a teacher?
  - b. How long have you been teaching in primary school?
  - c. Do you teach only mathematics or all the entire subjects?
  - d. How long have you taught mathematics for the fifth graders?
2. Practical setting
  - a. Is the tools (media) we need for the teaching and learning process for our chosen topics available?
3. About Students
  - a. How old are students in the fifth grade?
  - b. Could you classified students in fifth grade who are the high achievers and low achievers?
  - c. What do you think the difficulties which students will face in understanding the maps?
  - d. Have the fifth graders learned about the cardinal directions previously?
4. Pedagogical skill
  - a. Do you construct your own lesson plans?
  - b. What are the contents you consider in your lesson plans?
  - c. Have you ever had difficulties in applying your lesson plans? How do you tackle them?
  - d. What do you think the effective technique, strategy, or method in teaching math in the fifth grade?
  - e. How do you make students participated actively during your class?
  - f. How do you deal with the unmotivated students?
  - g. Do the students get used to work in small group?
  - h. How do you group the students? Based on their ability or merely randomly?
  - i. Do you also involve students in whole class discussion?
  - j. How do you manage your whole class discussion?
  - k. How do you support the students to be more active in the classroom discussion?
  - l. Do you always give hand-outs or worksheet while the teaching and learning process? Or do you merely use what in the textbook?
  - m. If using hand-outs or worksheet, how do you make them?

- n. If using textbook, what kind of textbook do you use to teach mathematics in the fifth grade?
  - o. Do you always follow the textbook in teaching mathematics?
  - p. How often do you use media in teaching mathematics?
  - q. What methods do you use to assess students learning? (formative and summative test)
  - r. Do you have experience in teaching the map reading for the fifth graders?
5. Classroom norms (Socio norms and sociomathematical norms)
- a. How do you manage your class? Do you have any specific rule in the class? (Reward or punishment, talking in forum, express opinion)
  - b. How do you respond to your wrong answer in your class?
  - c. How do you respond to your right answer in your class?
6. Knowledge of content (The topic of the study and RME/PMRI)
- a. Have you ever heard about PMRI?
  - b. What do you know about PMRI?
  - c. Have you joined the PMRI's workshop? If yes, can you describe what the interesting things you experienced there?
  - d. Have you ever experience teaching with this approach?
  - e. Do you think this approach is applicable or it is hard to apply?
  - f. One of important characteristic in PMRI is using real world contexts to introduce a new mathematics topic for students. What do you think about this?
  - g. Did you ever make a connection with the mathematical concepts and daily life in your teaching?
  - h. Related to my topic, do you think map skills have relation with mathematics?
  - i. Have you taught this topic before? If yes, how did you teach this topic?
  - j. What material did you use?
  - k. What is the difficulty to teach this topic based on your experience?
  - l. How many meetings do you need to teach the map reading?

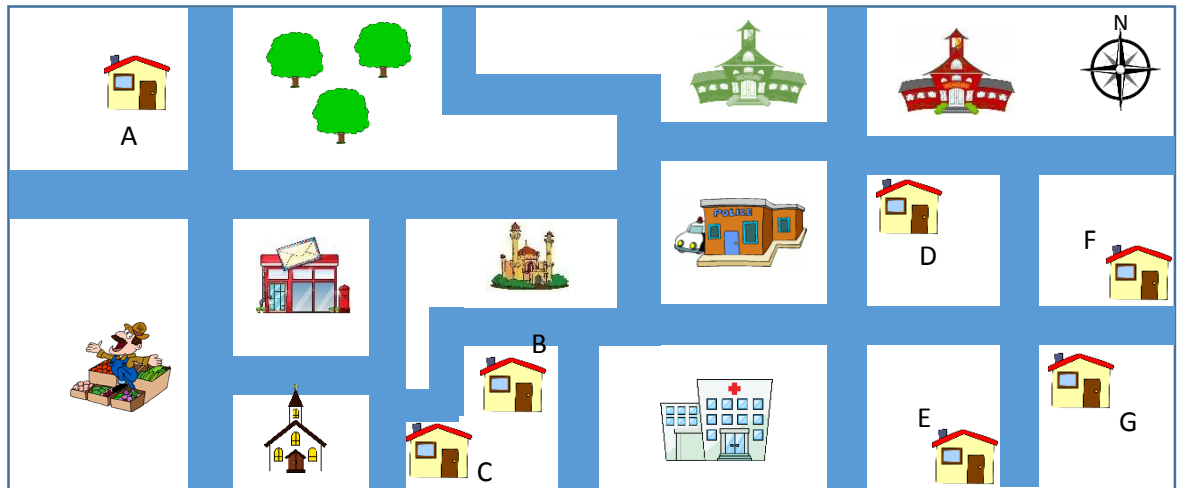
**Classroom Observation**

1. Practical setting
  - a. How many students are in the class?
  - b. How does the arrangement of students' seats?
  - c. What kind of instructional media is used in teaching and learning process?
  - d. Does the teacher use worksheet or textbook in the teaching and learning process?
  - e. What is the textbook used in the class?
2. Pedagogical skills of teacher:
  - a. How does teacher open the lesson?
  - b. How does teacher interact with students?
  - c. Where does the teacher position during the lesson? (standing in front of the class or moving around)
  - d. How do teacher guide the students to understand the topic?
  - e. Does the teacher give chance to the students to convey their idea and opinion?
  - f. How do the teacher deal with students who make distraction or too silent?
  - g. How does the teacher end the lesson?
  - h. How do teacher do his/her time management?
3. Socio norms & sociomathematical norms:
  - a. Does the teacher give a chance for students to think for a while before giving a response?
  - b. How does the teacher respond to wrong answer in the class?
  - c. How does the teacher respond to right answer in the class?
  - d. Is there any discussion about students' thinking and reasoning?
  - e. Does the teacher give reward or punishment?
  - f. Does the teacher emphasise that the different opinion of the students is appreciated?
  - g. How do the teacher respond different solutions from the students?
  - h. Does the teacher discuss with the students about elegant, efficient, sophisticated solution?
4. Students
  - a. Do the students work individually, in pairs, or groups? (If in groups, how does the teacher group the students?)
  - b. How do students work in the group?
  - c. How do students involve in the discussion both group or classroom discussion?

- d. If individually, how do students work individually?
- e. How do students interact to each other?
- f. Are students mostly silent or actively participate during the lesson?
- g. Is there any students who make distraction or too silent during the lesson?
- h. Do the students pay attention when the teacher gives an explanation?

**PRE-TEST (Cycle 1&2) AND POST-TEST (Cycle 1)**

Perhatikan gambar di bawah dan jawablah pertanyaan-pertanyaan berikut:

**LEGENDA**

 : rumah	 : kantor polisi	 : SD
 : pasar	 : SMP	
 : taman	 : Gereja	 : Rumah Sakit
 : kantor pos	 : Masjid	

- 1) Berilah petunjuk arah dari gereja ke bangunan SD.
- 2) Jika kalian harus menjelaskan posisi Masjid, bagaimana kalian menjelaskannya?
- 3) Jika kalian harus menjelaskan posisi taman, bagaimana kalian menjelaskannya?
- 4) Rumah Andi terletak di bagian timur perumahan di atas. Jika kamu berjalan lurus dari SMP ke selatan, kamu akan melihat kantor polisi di sebelah kanan kalian dan rumah Andi di sebelah kiri kalian. Disimbolkan dengan huruf apa rumah Andi?
- 5) Jika kamu berjalan dari rumah Andi, melewati kantor polisi dan berjalan ke selatan, kalian akan melihat rumah sakit di

sebelah kanan kalian dan rumah Sarah di sebelah kiri kalian.

Disimbolkan dengan huruf apa rumah Sarah?

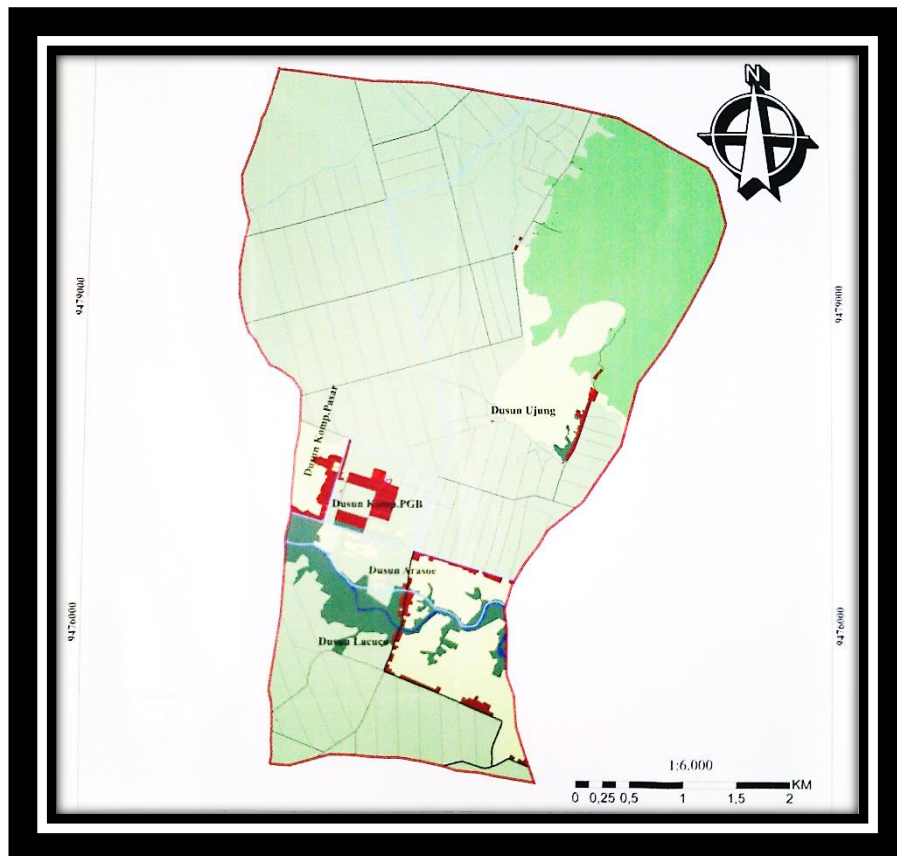
6) Di sebelah timur rumah Sarah adalah rumah Mary.

Disimbolkan dengan huruf apakah rumah Mary?

7) Rumah Dani terletak di daerah paling barat perumahan.

Disimbolkan dengan huruf apakah rumah Dani?

Perhatikan peta berikut!



8) Daerah apakah yang dipetakan pada gambar di atas?

Informasi apakah yang dapat kamu temukan dari gambar tersebut?

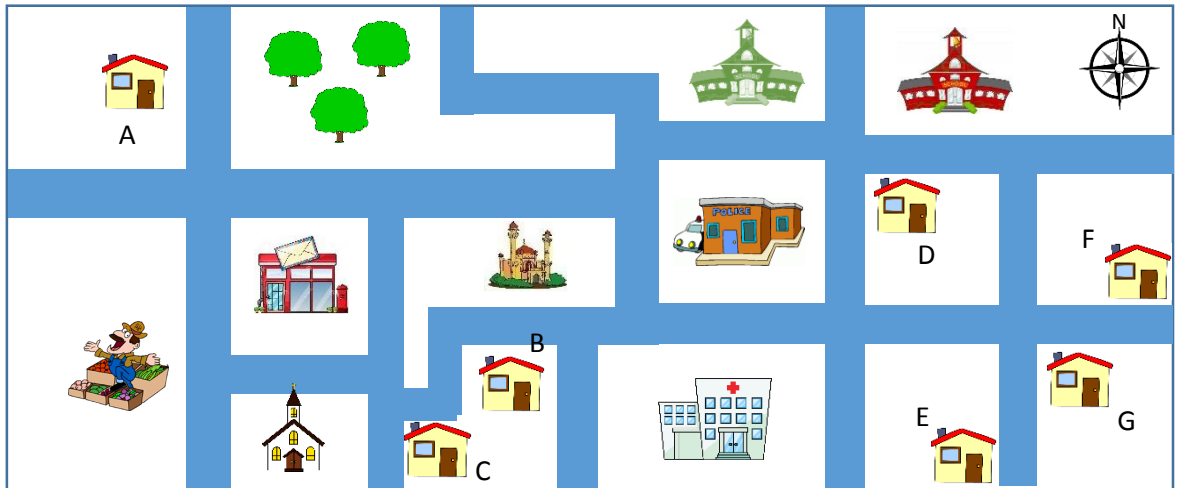
9) Dapatkan kalian menjelaskan posisi kalian di peta? Apakah mudah menemukan posisi kalian di peta? Mengapa?

10) Berilah petunjuk arah dari rumah kalian ke sekolah kalian.



**POST-TEST (Cycle 2)**

Perhatikan gambar di bawah dan jawablah 1-3 berdasarkan informasi yang terdapat pada gambar:

**LEGENDA**

 : rumah	 : kantor polisi	 : SD
 : pasar	 : SMP	
 : taman	 : Gereja	 : Rumah Sakit
 : kantor pos	 : Masiid	

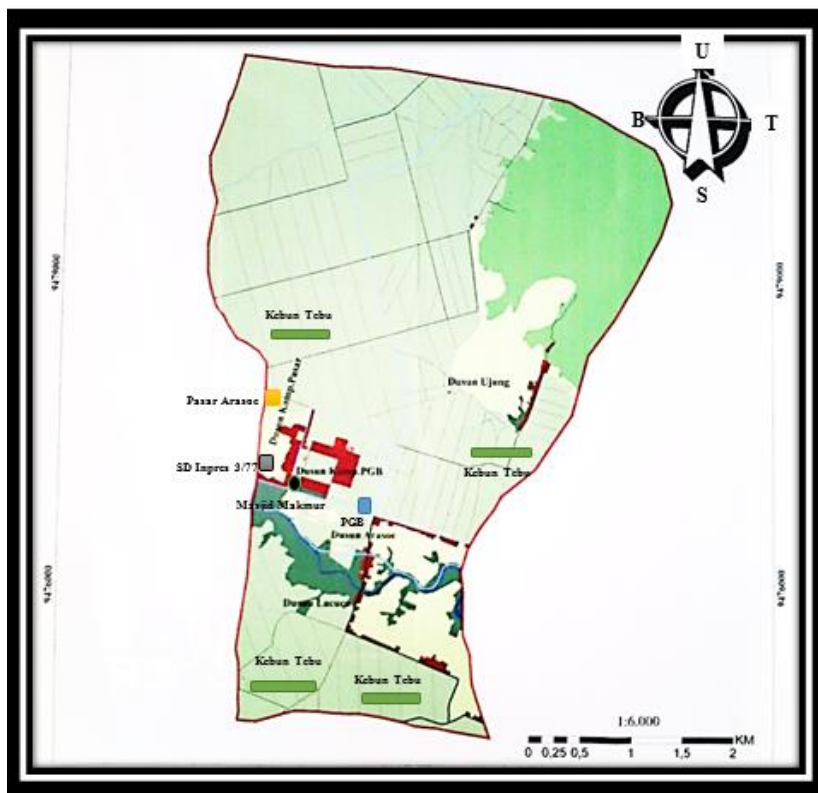
- 1) Bayangkan kalian sedang berada di jalan sebelah barat taman, kemudian berjalan terus ke selatan. Sesampainya di persimpangan tiga, kalian berbelok ke kiri. Jelaskan dimana posisi kalian sekarang pada peta!
- 2) Bayangkan kalian berada di jalan sebelah selatan taman dan sebelah utara kantor pos. Kemudian kalian berjalan ke timur. Tiba di persimpangan tiga, kalian berbelok ke kanan. Jelaskan dimana posisi kalian sekarang!
- 3) Bayangkan kalian berada di jalan yang membatasi gedung SD dan SMP, kemudian berjalan lurus ke selatan. Tiba di persimpangan empat, kalian berbelok kiri. Berjalan lurus dan

tiba di persimpangan tiga, kalian berbelok ke selatan. Jelaskan dimana posisi kalian sekarang!

- 4) Seorang perempuan mengambil gambar ketika matahari terbit di puncak gunung. Dia menghadap ke arah matahari terbit. Menghadap ke arah mata angin mana kah perempuan tersebut? Arah mata angin apa yang berada di sisi kanan dan sisi kirinya?



Perhatikan peta Desa Arasoe berikut!



- 5) Jelaskan posisi dusun Lacuco pada peta di atas!
- 6) Dimanakah posisi sekolah kalian di peta? Jelaskan bagaimana kalian mengetahui posisi sekolah kalian di peta?
- 7) Sebutkan tempat-tempat yang berada di sebelah timur sekolah kalian.
- 8) Sebutkan bangunan-bangunan yang berada di sebelah utara sekolah kalian.

**Pre-test and Post-test**

<b>Indicators</b>	<b>Purposes</b>	<b>Items in pre-test</b>	<b>Items in post-test</b>
Giving directions by utilizing cardinal directions and relative systems	<ol style="list-style-type: none"> <li>1. To check whether students give direction by utilizing cardinal directions and relative systems</li> <li>2. To check students' ability to follow and understand instructions using cardinal directions and relative systems</li> </ol>	1,4,5,6,7,10	1,2,3,4
Having and comprehending different reference points	To check the tendency of students while explaining a position of objects (what system they use)	2,3	1,2,3,5,6,7,8
Being able to do mental movement	To check the ability of students' mental movement and to check how familiar they are with the cardinal directions	4,5,6,7	1,2,3,4
Being familiar with the map of their environment.	To check students' familiarity with the map of their village.	8,9,10	5,6,7,8

**KEY ANSWER FOR PRE-TEST (Cycle 1 and Cycle 2) and POST-TEST (Cycle 1)**

Items	Example of students' answer	Ability
1	Standing in the east of the church, face north, go straight along the road, pass the post office and turn right, pass the Masjid and you'll pass the police station. Go straight to the east. You will be between two buildings. In your right is a house and the primary school building is on your left.	Good
	Go straight, turn right, go straight, turn left, turn right, and go straight.	Average
	No answer	Weak
2	Masjid is in the eastern part of the post office and western part police office	Good
	Masjid is in the center of the map	Average
	No answer	Weak
3	Park is in front of the post office; or Park is in the northern side of the post office	Good
	Park is in the upper part of the map.	Average
	No answer	Weak
4	D	Good
	wrong answer	Weak
5	E	Good
	wrong answer	Weak
6	G	Good
	wrong answer	Weak
7	A	Good
	wrong answer	Weak
8	Arasoe. The area of the village, the location of important places in Arasoe, location of Arasoe respects to other village in Cina	
	Arasoe or the location of important places in Arasoe	
	No answer	
9	Yes, I am in the southern part of the village. It is not that easy. I see Pabrik Gula Arasoe. Because it is not far from the school, then I found my location	
	I am in Dusun Ujung.	
	No answer	

Items	Example of students' answer	Ability
10	Go to the south and go straight until you see Masjid Makmur in your left. When you find T-junction, turn left and the school is in your left.	
	Go to the Pabrik Gula and go straight. After that, turn left. You arrive at school	
	No answer	

**KEY ANSWER FOR POST-TEST (Cycle 2)**

Items	Example of students' answer	Ability
1	Standing on the road between post office and the church. or Standing in the north of church and south of post office.	Good
	In front of the church; or in front of the post office	Average
	No answer	Weak
2	Standing on the road between post office and masjid. or Standing in the east of post office and west of masjid.	Good
	In the masjid; or beside post office	Average
	No answer	Weak
3	Standing on the road between house D and house F or Standing in the east of house D and west of F.	Good
	Beside house D or beside house F	Average
	No answer	Weak
4	East. In her left is north and her right is south	Good
	East. In her left is south and her right is north	Average-weak
5	Dusun Lacuco is in the west of Dusun Maccopo and in the north of Kec. Mare.	Good
	In the southern part of Arasoe Near Dusun Maccopo	Average
	No answer	Weak

Items	Example of students' answer	Ability
6	In the east of Dusun Jawi-Jawi'e. Because Dusun Jawi-Jawi'e is close to the school.	Good
	Near Dusun Jawi-Jawi'e	Average
	Wrong answer	Weak
7	Masjid Makmur, Kompleks PGB, Dusun Arasoe, Pabrik Gula, and so on (More than three places)	Good
	Masjid Makmur (only one place nearby)	Average
	No answer	Weak
8	Kompleks Pasar, Pasar Tradisional, STM Pembangunan, SMPN 1 Cina, and so on. (more than three places)	Good
	Kompleks Pasar (only one place nearby)	Average
	No answer	Weak

## LEMBAR KERJA SISWA (*Pertemuan 1*)

### Aktifitas 2

#### ARAH MATA ANGIN DAN POSISI MATAHARI



Perhatikan gambar di atas. Gambar tersebut diambil ketika matahari terbenam. Dalam gambar terlihat seorang anak berdiri membelakangi matahari.

1. Dapatkah kamu menentukan menghadap ke arah mata angin mana anak tersebut? Jelaskan jawabanmu!
2. Arah mata angin apakah di sebelah kiri dan di sebelah kanannya?
3. Gambarkan tanda panah yang menunjukkan arah mata angin pada gambar di atas

Jawaban:

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Gerbang utama sekolah

Pos



Taman Sekolah

SD Inpres  
12/79  
Arasoe

Tempat  
parkir

Lapangan Sekolah

Kosong

R. Sholat

Kelas II

Kelas I

R. Guru

R. Kepala  
Sekolah

Kelas III

Kelas IV

Kelas VI

Kelas VA

Kelas VB

Perpustakaan

Toilet

**DENAH SD INPRES 3/77 ARASOE**

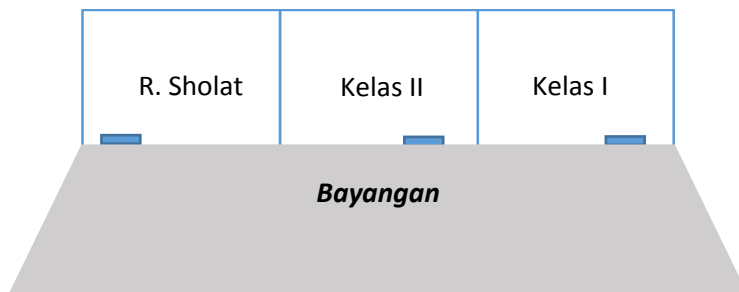
### Aktifitas 3

#### BERMAIN DETEKTIF (MENCARI BARANG BUKTI)

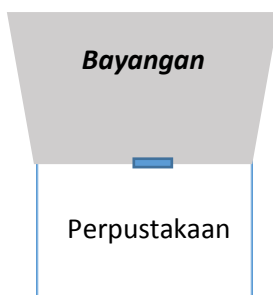
Di halaman terakhir terdapat peta sekolah. Kalian akan menggunakan peta ini untuk memainkan permainan ini. Dalam bermain mencari barang bukti, kalian harus mencari beberapa barang yang telah ditempatkan di beberapa tempat di lingkungan sekolah. Berikut petunjuk tentang lokasi setiap objek.

#### **Petunjuk**

Pada saat matahari terbit, terbentuk bayangan bangunan kelas dan ruang sholat seperti di bawah ini:



Ketika matahari terbenam, bayangan dari perpustakaan sekolah adalah sebagai berikut:



**Objek 1:** Dari posisi kalian sekarang. Keluar dan berbeloklah ke utara. Kemudian beloklah ke kanan, berjalan lurus dan ruang kelas IV berada di sebelah timur objek 1 dan ruang kelas V A di sebelah selatan objek 1.

**Objek 2:** Jika kamu berdiri di depan kelas IV, berjalan ke timur, objek 2 tepat berada di depan ruangan yang berada di sebelah selatan ruang sholat dan di sebelah utara ruang kelas 1.

**Objek 3:** Dari depan pintu ruang sholat, kalian menghadap arah barat dan berjalan lurus lah. Ketika tiba di depan ruang kelas VI, berbeloklah ke selatan dan objek 3 berada di depan ruangan di sebelah utara kelas VA.

**Objek 4:** Berdirilah di depan kelas VB berjalan kearah selatan. Tiba pada ujung lapangan, berbeloklah ke timur. Berjalan luruslah, kalian akan menemukan objek 4 di sebelah utara gerbang utama sekolah.

**Objek 5:** Dari gerbang sekolah berjalanlah ke barat dan berbelok kanan lah ketika melihat perpustakaan di hadapan kalian. Lokasi objek 5 berada di sebelah utara perpustakaan dan

**Pertanyaan**

- 1) Temukan arah mata angin pada peta berdasarkan petunjuk yang ada.
- 2) Temukan lokasi dari setiap objek dan beri tanda silang (X) untuk setiap posisi di peta.
- 3) Gambarkan rute yang kalian lewati pada peta.



**LEMBAR KEGIATAN SISWA (Pertemuan 2)****Aktifitas 1****MENEMUKAN LOKASI DI PETA**

Perhatikan peta pada halaman 2.

**Pertanyaan**

- Tahukah kalian daerah apakah yang digambarkan pada peta tersebut?
- Dapatkan kalian menemukan lokasi-lokasi yang kalian tahu posisinya di peta tersebut? Berilah tanda silang (X) di lokasi tempat tersebut di peta.
- Jelaskan bagaimana cara kalian menemukan lokasi-lokasi tersebut!

Jawaban:

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## Aktifitas 2

MEMBAGI WILAYAH BERDASARKAN  
ARAH MATA ANGIN

### Pertanyaan

- Dapatkah kamu menemukan posisi Pabrik Gula Bone, Pasar Traditional Arasoe, Masjid Makmur, Kebun Tebu, dan sekolah kalian pada peta desa Arasoe?
- Setelah melabeli beberapa lokasi di peta, bagilah wilayah Desa Arasoe berdasarkan arah mata angin (Arasoe bagian utara, Arasoe bagian selatan, Arasoe bagian barat, dan Arasoe bagian timur). Tuliskan tempat-tempat yang menjadi bagian dari tiap pembagian wilayah.

Jawaban:

[illegible]



# MAP OF MAKASSAR





## LEMBAR KERJA SISWA (Pertemuan 3)

### Aktifitas 1

#### MELENGKAPI PETA WISATA KOTA MAKASSAR

Pada halaman pertama terdapat peta Kota Makassar. Dalam menyelesaikan tugas ini, kalian harus melengkapi peta (*keterangan nama dari beberapa lokasi, bangunan, jalan*) ikuti instruksi berikut untuk melengkapi legenda dari peta.



#### **Petunjuk**

Dari Bone, kalian akan melewati “Bantimurung”. Berjalan lurus terus sampai “Tol Reformasi”. Di sebelah utara jalan kalian dapat melihat “Pelabuhan Paotere”. Selanjutnya, kalian akan tiba di persimpangan, belok kiri ke “Jl. Yos Sudarso”. Berjalan lurus ke “Jl. Andalas”, di sebelah kanan kalian, kalian akan melihat “gereja”. Di sebelah utara gereja, kalian akan menemukan “Makam Diponegoro”. Berjalan terus sampai kalian tiba di “Masjid Agung”. Kemudian belok kanan ke “Jl. Bulu Saraung”. Berjalan lurus ke “Jl. Ahmad Yani”, kalian akan melihat “Lapangan Karebosi” di sebelah selatan jalan. Berjalan terus sampai kalian menemukan pantai dan berjalanlah ke arah selatan “Jl. Ujung Pandang”. Di sebelah timur jalan kalian akan menemukan “Fort Rotterdam”. Lanjutkan perjalanan kalian sepanjang pantai. Kalian akan melihat “mercure” di sebelah timur “Jl. Pasar Ikan” dan di sebelah selatan mercure kalian akan menemukan “Rumah Sakit 1” serta “Masjid”. Berjalan lurus ke “Jl. Gagak” dan beloklah ke kiri ke “Jl. Kakatua”. Di sebelah utara “Jl. Kakatua”, kalian dapat melihat “Gelora Andi Mattalatta”. Kemudian, beloklah ke kanan dan di sebelah kiri kalian adalah “Rumah Sakit 2”. Lanjutkan perjalanan kalian dengan berjalan terus. Setelah melewati perempatan, di sebelah kanan, kalian akan menemukan “Pasar Pabaeng-baeng” dan selanjutnya “Terminal Bus”. Lanjutkan perjalanan kalian ke bagian selatan kota Makassar. Setelah mengendarai mobil selama 2 jam, kalian akan tiba di Malino.



**Pertanyaan:**

1. Berdasarkan petunjuk di atas, lengkapi peta wisata Kota Makassar. Berilah nama pada label situs, bangunan, atau jalan yang disebutkan dalam petunjuk tersebut.

Jawaban:

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**LEMBAR KERJA SISWA****Aktifitas 2****Pertanyaan**

- 1) Buatlah rencana bagaimana kalian akan menghabiskan waktu di Kota Makassar selama 1 hari. (*Pertimbangkan semua hal-hal penting, seperti tempat menarik, Musholla, tempat makan siang, dan lain-lain*)
- 2) Jelaskan arah yang kalian pilih untuk perjalanan kalian dari titik awal sampai titik akhir perjalanan kalian. (*Kalian dapat menggunakan arah mata angin atau sistem navigasi (kiri, kanan, depan, belakang)*)

Jawaban:

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### **Rencana Pelaksanaan Pembelajaran dan Petunjuk Guru**

Aktivitas Pembelajaran yang Melibatkan Peta dan Arah Mata Angin untuk Mendukung Perkembangan Kemampuan Spasial Orientasi Siswa

#### **Catatan Penting:**

Hal yang ditekankan pada kegiatan pembelajaran ini adalah bukan jawaban benar dari siswa. Berikut hal-hal penting yang harus dicapai siswa:

- Siswa menggunakan sistem (arah mata angin ataupun sistem navigasi) dalam menyelesaikan masalah yang diberikan.
- Siswa mengungkapkan pendapat dan idenya.
- Siswa diberikan kesempatan untuk berdiskusi dan memberikan tanggapan terhadap pendapat orang lain.
- Siswa harus menjelaskan jawaban mereka dan bagaimana cara mereka menemukan jawaban tersebut. Hal ini dapat membantu siswa lain yang mengalami kesulitan dalam membaca dan menginterpretasi informasi pada peta.
- Kegiatan pembelajaran ini bertujuan untuk memberikan kesempatan kepada siswa untuk mendapatkan pengalaman membaca peta dan menggunakan kemampuan spasial mereka.

## RENCANA PELAKSANAAN PEMBELAJARAN

<b>SD/MI</b>	<b>:</b>	<b>SD Inpres 3/77 Arasoe</b>
<b>Mata Pelajaran</b>	<b>:</b>	<b>Matematika</b>
<b>Kelas/Semester</b>	<b>:</b>	<b>V / 2 ( Genap)</b>
<b>Alokasi Waktu</b>	<b>:</b>	<b>2 Jam pelajaran (1 x pertemuan)/2x35 Menit</b>
<b>Pertemuan</b>	<b>:</b>	<b>1</b>
<b>Pokok Bahasan</b>	<b>:</b>	<b>Membaca Peta</b>

### **Indikator:**

1. Menunjukkan arah mata angin
2. Membaca dan menggunakan peta

### **Tujuan Pembelajaran:**

1. Siswa dapat menentukan arah mata angin.
2. Siswa dapat membaca peta sederhana.
3. Siswa dapat menentukan lokasi di peta, termasuk posisi mereka.

### **Deskripsi Singkat Kegiatan Pembelajaran**

Kegiatan-kegiatan dalam pembelajaran ini memberikan kesempatan kepada siswa mendiskusikan bagaimana cara mereka menentukan arah mata angin dan mengerti bagaimana konsep ini terkait dengan kehidupan sehari-hari mereka. Selain itu, dalam pembelajaran ini mereka akan menggunakan pengetahuan tentang arah mata angin dan kemampuan spasial mereka dalam menyelesaikan masalah-masalah yang diberikan.

### **Persiapan (5 menit)**

1. Guru membuka pembelajaran
2. Guru mempersiapkan siswa untuk menerima pembelajaran (berdoa, mengecek kehadiran, dan lain-lain).

### **Kegiatan Pembelajaran (63 menit)**

#### ***Kegiatan Pembuka (5 menit): Dimanakah Utara?***

Kegiatan 1 merupakan kegiatan pemanasan dimana guru memberikan kesempatan kepada siswa untuk mengungkapkan semua hal yang mereka ketahui tentang arah mata angin.

1. Guru menyuruh siswa untuk menutup mata dan menunjuk arah utara.

*Hipotesis Jawaban Siswa:*

Siswa menunjuk arah yang berbeda-beda. Beberapa diantaranya akan menunjukkan arah yang benar dan beberapa menunjukkan arah yang salah

2. Guru menanyakan kepada siswa: “Bagaimana cara kalian menentukan arah yang kalian tunjukkan adalah utara?”

<i>Hipotesis Jawaban Siswa</i>	<i>Tanggapan Guru</i>
Siswa menunjukkan ke arah di depan mereka, karena mereka berpendapat utara selalu berada di depan mereka.	<ul style="list-style-type: none"> <li>• Jika kalian berada di kelas 2 dan duduk menghadap ke papan tulis maka arah utara kalian akan berubah ke arah sebaliknya. Bagaimana menurut mu? Apakah arah mata angin itu berubah-ubah berdasarkan posisi badan kalian?</li> </ul>
Siswa mengetahui arah utara karena pernah mengerjakan tugas di pelajaran IPS sebelumnya.	<ul style="list-style-type: none"> <li>• Iya. Teman kalian berpendapat utara di sebelah sana (<i>menunjukkan arah yang ditunjukkan siswa</i>). Apakah kalian yakin dengan jawaban tersebut?</li> </ul>
Siswa menggunakan bangunan yang mereka kenali di sekolah sebagai dasar (misalnya: Ruang Sholat yang menghadap ke arah kiblat (Barat))	<ul style="list-style-type: none"> <li>• Tentu kalian bisa menggunakan ruang sholat, masjid ataupun Musholla.</li> <li>• Selain Musholla, kira-kira bangunan apa lagi yang bisa kita gunakan untuk menentukan arah mata angin? (<i>Guru dapat menanyakan pertanyaan ini ke seluruh siswa</i>)</li> </ul>

3. Guru melanjutkan pertanyaan: “Apakah yang dapat kita gunakan untuk meyakinkan orang lain bahwa arah mata angin yang kita tunjukkan benar selain menggunakan bangunan tadi?”

<i>Hipotesis Jawaban Siswa</i>	<i>Tanggapan Guru</i>
<ul style="list-style-type: none"> <li>• Siswa menyebutkan matahari.</li> <li>• Siswa menjelaskan bahwa matahari selalu terbit di timur dan tenggelam di barat.</li> </ul>	<ul style="list-style-type: none"> <li>• Iya. Kalian dapat menggunakan matahari. Bagaimana caranya? Dapatkah kalian menjelaskannya lebih lanjut?</li> </ul>

<i>Hipotesis Jawaban Siswa</i>	<i>Tanggapan Guru</i>
<ul style="list-style-type: none"> <li>Siswa menyebutkan kompas</li> </ul>	<ul style="list-style-type: none"> <li>Iya. Kalian dapat menggunakan kompas untuk menentukan arah mata angin.</li> </ul>

4. Guru menyimpulkan jawaban-jawaban yang diberikan siswa.

***Kegiatan 2 (20 menit): Matahari dan Arah Mata Angin***

Kegiatan 2 memberikan kesempatan kepada siswa untuk menggunakan pengetahuan mereka tentang hubungan arah mata angin dan matahari dalam menyelesaikan masalah yang diberikan.

1. Guru mengingatkan jawaban siswa pada kegiatan sebelumnya tentang menentukan arah mata angin, khususnya arah utara dengan menggunakan posisi matahari.
2. Guru menjelaskan kepada siswa bahwa mereka akan menyelesaikan sebuah masalah yang terkait dengan konsep arah mata angin.
3. Guru menjelaskan masalah yang akan diselesaikan kepada siswa dengan menceritakan kutipan cerita berikut ini sambil menunjukkan gambar di bawah:  
(2 menit)

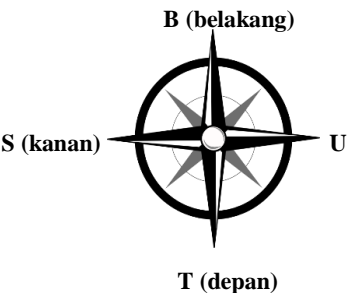
“Minggu lalu, saya mengambil gambar anak-anak yang sedang bermain sepak bola di dekat rumah saya. Saya mengambil gambar ini ketika matahari sedang terbenam.”



“Jika kalian memperhatikan gambar ini, kalian akan melihat seorang anak laki-laki yang berdiri membelakangi matahari. Berdasarkan informasi dari gambar ini, dapatkan kalian menentukan arah mata angin?”

4. Guru menjelaskan bahwa siswa akan menyelesaikan masalah ini dengan mendiskusikannya dengan pasangan mereka.
5. Guru membagikan LKS (*LKS Pertemuan 1, Kegiatan 1*) kepada setiap pasangan siswa.
6. Guru memberikan waktu kepada siswa untuk menyelesaikan masalah tersebut selama 8 menit.
7. Guru berkeliling dan mengamati diskusi dan jawaban siswa
8. Guru membuka diskusi kelas. (*Diskusi kelas berjalan selama 10 menit*)
9. Guru memilih 2 kelompok yang memiliki jawaban yang menarik (satu jawaban salah dan satu jawaban benar jika ada. Namun jika semua siswa benar atau semua salah, maka cukup memilih 1 jawaban saja)
10. Guru memberikan kesempatan kepada siswa untuk mempresentasikan hasil diskusi mereka.
11. Guru memberikan kesempatan kepada kelompok lain untuk menanggapi jawaban dari kelompok presenter.

No	Pertanyaan pada LKS	Hipotesis Jawaban Siswa	Tanggapan Guru
1	Dapatkah kamu menentukan menghadap ke arah mata angin mana anak tersebut? Jelaskan jawabanmu!	Anak itu menghadap ke timur. Karena anak tersebut membelakangi matahari yang sedang terbenam di barat, maka dia menghadap ke timur.	Ketika siswa masih kesulitan dalam menemukan jawaban, guru dapat memberikan pertanyaan bantuan sebagai berikut: <ul style="list-style-type: none"> <li>• Tahukah kalian matahari terbit dari arah mana dan tenggelam di arah mana?</li> <li>• Kalian dapat membayangkan, jika cahaya datang dari arah ini ketika matahari terbenam Arah mana kah itu?</li> </ul>
2	Arah mata angin apakah di sebelah kiri dan di sebelah kanannya?	Di sebelah kiri adalah utara dan di sebelah kanan adalah selatan	

No	Pertanyaan pada LKS	Hipotesis Jawaban Siswa	Tanggapan Guru
3	Gambarkan tanda panah yang menunjukkan arah mata angin pada gambar di atas		

**Kegiatan 3 (35 menit): Bermain Detektif (Mengumpulkan Barang Bukti)**

Kegiatan 3 memberikan kesempatan kepada siswa untuk menggunakan kemampuan spasial orientasi mereka dan pengetahuan yang mereka peroleh pada kegiatan sebelumnya (kegiatan 2). Mereka akan bermain detektif dan mengumpulkan beberapa objek yang telah ditempatkan di beberapa lokasi di sekolah. Selain itu, siswa juga harus memberikan tanda silang pada posisi benda-benda tersebut di peta.

1. Guru menjelaskan kepada siswa kegiatan yang akan dilakukan dan aturan dari permainan detektif ini. Aturan permainan detektif adalah sebagai berikut: (5 menit)
  - Siswa menyelesaikan masalah yang diberikan secara berkelompok.
  - Siswa harus menemukan lima benda yang ditempatkan di beberapa tempat di sekolah.
  - Siswa harus menemukan objek berdasarkan urutannya.
  - Di beberapa lokasi, terdapat beberapa objek pengecoh yang bukan merupakan barang bukti yang harus dikumpulkan.
  - Sebelum menemukan objek, siswa harus menyelesaikan masalah pertama, yaitu menentukan arah mata angin pada peta.
  - Petunjuk dari lokasi lima objek terdapat di LKS.
2. Guru membagi kelas ke dalam kelompok-kelompok kecil yang terdiri dari tiga siswa.



3. Guru membagikan LKS (*LKS Pertemuan 1, Kegiatan 2*).
4. Guru menginstruksikan siswa untuk membaca LKS (*LKS Pertemuan 1, Kegiatan 2*) dan menyelesaikan soal 1.
5. Guru menekankan bahwa posisi arah mata angin pada denah sekolah harus disesuaikan dengan keadaan yang sebenarnya, sehingga arah utara yang umumnya berlaku pada peta pada umumnya tidak berlaku dalam soal tersebut.
6. Guru menginstruksikan siswa untuk melanjutkan ke soal-soal berikutnya.
7. Guru membuka diskusi kelas. Diskusi berjalan selama 10 menit.
8. Guru menunjukkan gambar peta sekolah yang lebih besar di depan kelas.
9. Guru menunjuk salah satu kelompok untuk mempresentasikan jawaban mereka di depan kelas dan memberi tanda pada peta lokasi tiap objek beserta rute yang ditempuh siswa.
10. Guru menanyakan pendapat kelompok lain yang memiliki jawaban yang berbeda.

No	Pertanyaan	Hipotesis Jawaban Siswa	Tanggapan Guru	Hipotesis Tanggapan Siswa
1	Temukan arah mata angin pada peta berdasarkan petunjuk yang ada.	<p>Beberapa kelompok menemukan jawaban yang benar:  <i>Berdasarkan hasil diskusi pada aktifitas 1, siswa mengetahui posisi kelas mereka menghadap ke utara, maka gerbang sekolah (bagian atas peta) berada di bagian timur.</i></p> <p>Beberapa siswa yang lain memiliki jawaban yang salah:</p> <ul style="list-style-type: none"> <li>• <i>Siswa menukar posisi timur dan barat pada peta.</i></li> </ul> <p><i>Siswa langsung memposisikan utara pada bagian atas peta, selatan di bagian bawah peta, timur di</i></p>	Guru mengingatkan siswa bahwa menentukan arah mata angin pada peta sangat penting agar siswa tidak salah dalam mengikuti petunjuk.	

		<i>bagian kanan peta, dan barat di bagian kiri peta</i>		
2	Temukan lokasi dari setiap objek dan beri tanda silang (X) untuk setiap posisi di peta.	<ul style="list-style-type: none"> <li>Siswa menandai lokasi yang benar: <i>Siswa menandai lokasi objek 1 di toilet pada peta, objek 2 pada kelas IV, dst.</i></li> <li>Siswa menandai lokasi yang salah: <i>Siswa menandai lokasi objek 1 di kelas VI, objek 3 di lapangan, dst.</i></li> <li>Siswa menggambarkan jalur rute yang benar yang mereka tempuh.</li> <li>Siswa menggambarkan jalur rute yang salah yang mereka tempuh</li> </ul>	<p>Dalam diskusi, guru dapat menanyakan:</p> <ul style="list-style-type: none"> <li>Menurut kalian, apakah yang membuat jawaban kalian berbeda?</li> </ul>	<ul style="list-style-type: none"> <li>Siswa menyadari arah mata angin pada peta mereka berbeda.</li> <li>Siswa menyadari beberapa jawaban salah.</li> </ul>

11. Guru memberikan respon terhadap jawaban siswa dan menekankan bahwa sistem navigasi (kanan, kiri, depan dan belakang) dan arah mata angin bermanfaat. Selain itu, guru mengingatkan siswa untuk memperhatikan sistem navigasi yang terkadang membingungkan karena sistem tersebut didasarkan pada posisi pembicara.
12. Guru menjelaskan bahwa siswa dapat menggunakan setiap sistem selama orang lain dapat mengerti instruksi yang kita jelaskan.

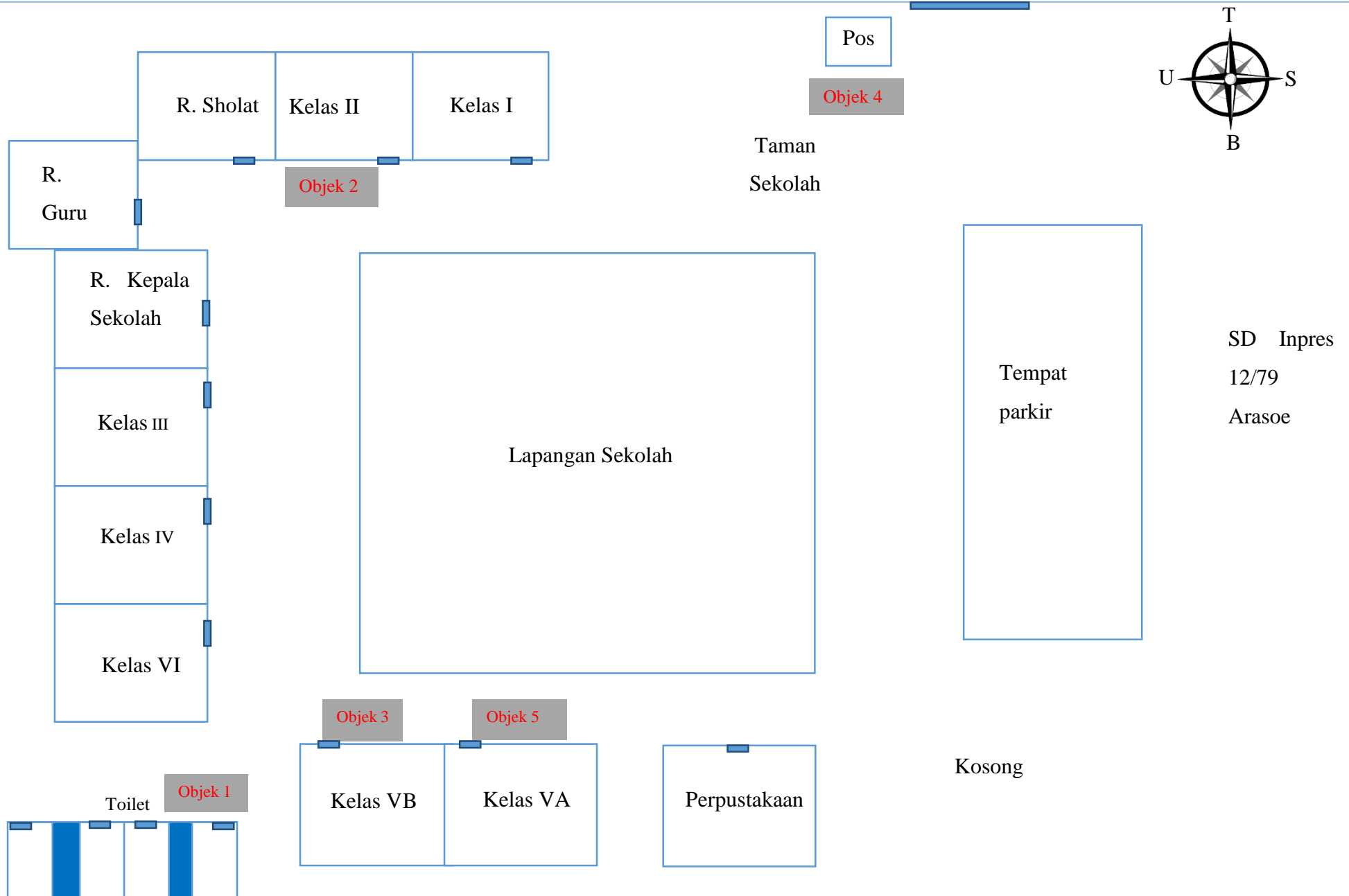
**Penutup (2 menit)**

Guru merefleksikan pembelajaran dengan menanyakan beberapa pertanyaan, yaitu:

- Apakah yang telah kita pelajari?
- Apakah manfaat dari materi yang kita pelajari?

## Appendix F

Gerbang utama sekolah



### RENCANA PELAKSANAAN PEMBELAJARAN

<b>SD/MI</b>	<b>:</b>	<b>SD Inpres 3/77 Arasoe</b>
<b>Mata Pelajaran</b>	<b>:</b>	<b>Matematika</b>
<b>Kelas/Semester</b>	<b>:</b>	<b>V / 2 ( Genap)</b>
<b>Alokasi Waktu</b>	<b>:</b>	<b>2 Jam pelajaran (1 x pertemuan)/2x35 Menit</b>
<b>Pertemuan</b>	<b>:</b>	<b>2</b>
<b>Pokok Bahasan</b>	<b>:</b>	<b>Membaca Peta</b>

#### **Indikator:**

1. Mengenali peta daerah tempat tinggal.

#### **Tujuan Pembelajaran**

1. Siswa dapat memiliki gambaran umum tentang peta daerah tempat mereka tinggal.
2. Siswa dapat mengidentifikasi tempat di peta.
3. Siswa dapat menggunakan kemampuan spasial mereka untuk memecahkan masalah.

#### **Deskripsi Singkat Kegiatan Pembelajaran**

Kegiatan ini memberikan kesempatan kepada siswa untuk membangun dalam pikiran peta daerah tempat mereka tinggal.

#### **Persiapan (5 menit)**

1. Guru membuka pembelajaran
2. Guru mempersiapkan siswa untuk menerima pembelajaran (berdoa, mengecek kehadiran, dan lain-lain).

#### **Kegiatan Pembelajaran (62 menit)**

##### ***Kegiatan 1 (30 minutes)***

Dalam kegiatan 1 siswa diharapkan menggunakan pengetahuan dan pengalaman mereka untuk melengkapi peta desa Arasoe.

1. Guru menunjukkan peta buta desa Arasoe.



2. Guru menanyakan kepada siswa adakah yang mengenali peta tersebut?  
“Apakah ada yang mengenali daerah apa yang dipetakan pada gambar ini?”  
*Hipotesis Jawaban Siswa:*
  - 1) Siswa mengenali peta desa Arasoe
  - 2) Siswa tidak mengenali peta desa Arasoe
3. Jika tidak ada yang mengenali, guru memberitahukan kepada siswa bahwa gambar tersebut adalah peta Arasoe.
4. Guru membagi kelas dalam kelompok-kelompok kecil yang terdiri dari 3 orang.
5. Guru menjelaskan bahwa pada pertemuan kali ini mereka akan menggunakan peta desa Arasoe.
6. Guru membagikan peta kepada tiap group beserta LKS.
7. Guru menyuruh siswa untuk berdiskusi dan memberi nama pada lokasi daerah yang mereka ketahui di peta beserta alasan dari jawaban mereka. (20 menit)

<i>Pertanyaan</i>	<i>Hipotesis Jawaban Siswa</i>	<i>Tanggapan Guru</i>
Tahukah kalian daerah apakah yang digambarkan pada peta tersebut?		Guru menyuruh siswa untuk memperhatikan posisi desa lain pada peta dan menanyakan daerah di desa Arasoe yang berdekatan dengan desa tersebut.
Dapatkan kalian menemukan lokasi-lokasi yang kalian tahu posisinya di peta tersebut? Berilah tanda silang (X) di lokasi tempat tersebut di peta.	Siswa menemukan posisi suatu tempat berdasarkan lokasi desa lain. Siswa tidak mengetahui posisi suatu tempat sama sekali.	Jika siswa tetap mengalami kesulitan, guru dapat memberi bantuan dengan memberikan posisi 1 tempat (misalnya lokasi Masjid Makmur di peta)
Jelaskan bagaimana cara kalian menemukan lokasi-lokasi tersebut!		

8. Guru menempelkan peta buta desa Arasoe pada papan tulis dan menyuruh 3 atau 4 kelompok untuk maju ke depan dan memberi label pada peta beserta penjelasannya. (10 menit)
9. Guru menanyakan kepada kelompok lain apakah ada yang memiliki pertanyaan atau tanggapan terhadap jawaban kelompok presenter.

**Kegiatan 2 (30 menit)**

10. Guru selanjutnya membagikan LKS 2. (2 menit)

“Selanjutnya kita akan melengkapi lebih banyak lagi tempat-tempat pada peta desa Arasoe. Kalian dapat membaca pertanyaan yang ada pada LKS kalian”

<i>Pertanyaan</i>	<i>Hipotesis Jawaban Siswa</i>	<i>Tanggapan Guru</i>
Dapatkah kamu menemukan posisi Pabrik Gula Bone, Pasar Traditional Arasoe, Masjid Makmur, Kebun Tebu, dan sekolah kalian?	Siswa menemukan posisi semua tempat yang ditanyakan.	Guru menanyakan alasan siswa.
	Siswa mengalami kesulitan dalam menemukan lokasi tempat-tempat tersebut di peta	Dalam hal ini, guru dapat membantu dengan menggunakan tempat-tempat yang berada di sekitar sekolah dan

<i>Pertanyaan</i>	<i>Hipotesis Jawaban Siswa</i>	<i>Tanggapan Guru</i>
		menentukan lokasinya berdasarkan arah mata angin
Setelah melabeli beberapa lokasi di peta, bagilah wilayah Desa Arasoe berdasarkan arah mata angin (Arasoe bagian utara, selatan, barat, dan timur). Tuliskan tempat-tempat yang menjadi bagian dari tiap pembagian wilayah.		

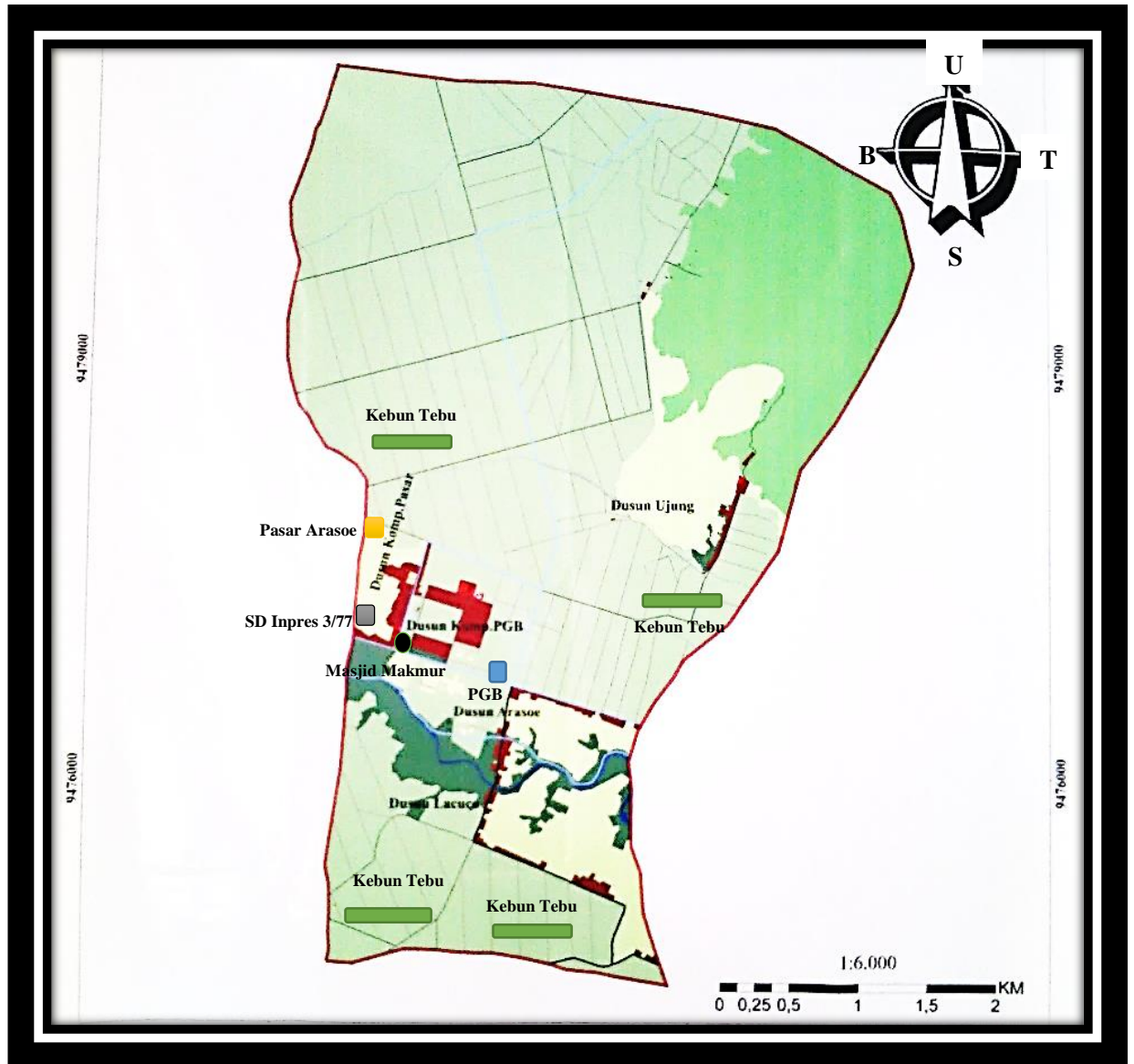
11. Guru memberikan kesempatan kepada siswa untuk berdiskusi selama 20 menit.
12. Guru berkeliling dan mengawasi jalannya diskusi.
13. Guru membuka diskusi kelas yang akan dilaksanakan selama (10 menit)
14. Guru menunjukkan peta yang telah dilengkapi pada kegiatan sebelumnya.
15. Guru menunjuk siswa dari beberapa kelompok untuk melengkapi peta desa Arasoe.
16. Guru menanyakan ke semua siswa bagaimana cara mereka membagi wilayah desa Arasoe berdasarkan arah mata angin.  
*Hipotesis jawaban siswa:* Setiap kelompok membagi wilayah secara berbeda
17. Guru menunjuk salah satu kelompok untuk menggambarkan pembagian wilayah mereka.
18. Guru menanyakan pendapat kelompok lain.
19. Guru memilih salah satu cara terbaik untuk membagi wilayah desa Arasoe dan memberikan sedikit penjelasan.

**Penutup (3 menit)**

Guru merefleksi pembelajaran dengan menanyakan beberapa pertanyaan, yaitu:

- Apakah yang telah kita pelajari?
- Apakah manfaat dari materi yang kita pelajari?

# PETA DESA ARASOE





### RENCANA PELAKSANAAN PEMBELAJARAN

<b>SD/MI</b>	<b>:</b>	<b>SD Inpres 3/77 Arasoe</b>
<b>Mata Pelajaran</b>	<b>:</b>	<b>Matematika</b>
<b>Kelas/Semester</b>	<b>:</b>	<b>V / 2 ( Genap)</b>
<b>Alokasi Waktu</b>	<b>:</b>	<b>2 Jam pelajaran (1 x pertemuan)/2x35 Menit</b>
<b>Pertemuan</b>	<b>:</b>	<b>3</b>
<b>Pokok Bahasan</b>	<b>:</b>	<b>Membaca Peta</b>

**Indikator:**

1. Membaca dan menggunakan peta lokasi yang tidak familiar

**Tujuan Pembelajaran:**

1. Siswa dapat membaca peta dan memaknai simbol-simbol yang digunakan pada peta.
2. Siswa dapat menemukan cara yang efisien untuk berjalan di suatu tempat.
3. Siswa dapat menggunakan kemampuan spasial mereka untuk menyelesaikan masalah yang diberikan.

**Deskripsi Singkat Kegiatan Pembelajaran**

Pada kegiatan ini, siswa menggunakan dan membaca peta lokasi yang mereka tidak kenali. Siswa diharapkan dapat membayangkan dirinya bergerak dan berjalan di tempat yang dipetakan.

**Persiapan (5 menit)**

1. Guru membuka pembelajaran
2. Guru mempersiapkan siswa untuk menerima pembelajaran (berdoa, mengecek kehadiran, dan lain-lain).

***Kegiatan 1 (30 menit): Melengkapi Peta Wisata Kota Makassar***

Pada kegiatan ini, siswa diberikan tugas untuk menamai bangunan, tempat, ataupun jalan pada peta wisata kota Makassar. Petunjuk yang diberikan menggunakan arah mata angin dan sistem navigasi (kanan, kiri, depan, belakang). Oleh karena itu, siswa harus menggunakan kemampuan spasial mereka untuk menyelesaikan tugas ini.

1. Guru menjelaskan kepada siswa tentang kegiatan yang akan mereka lakukan pada pertemuan ini.
2. Guru membagi kelas menjadi kelompok-kelompok kecil yang terdiri dari 3 orang.
3. Guru menjelaskan konteks permasalahan yang akan dibahas pada pertemuan ini. (2 menit)

“Pernahkah kalian mendengar kata study tour? Study tour adalah kegiatan mengunjungi suatu tempat sambil mempelajari hal-hal yang terkait dengan tempat tersebut. Siswa kelas 6 berencana untuk melakukan study tour selama 3 hari (1 hari di Makassar dan 2 hari di Malino). Teman dari ibu kepala sekolah yang bekerja di dinas pariwisata membantu kita dengan memberikan peta wisata kota Makassar. Sayangnya, peta yang diberikan tidak lengkap karena ada beberapa tempat, jalan, bangunan yang tidak memiliki nama di peta. Kepala sekolah meminta kelas 5 untuk melengkapi peta tersebut agar perjalanan study tour kelas 6 nantinya dapat lebih mudah. Nanti ibu akan memberikan kalian peta wisata kota Makassar. Kalian diberi tugas untuk menamai tempat-tempat tersebut berdasarkan petunjuk yang diberikan oleh teman dari ibu kepala sekolah”



4. Guru membagikan peta dan instruksinya kepada setiap kelompok.
5. Guru memberikan kesempatan kepada siswa untuk berdiskusi dengan kelompok mereka. (20 menit)
6. Guru berkeliling dan mengawasi jalannya diskusi.

Note:

Ketika siswa mengalami kesulitan menjawab pertanyaan, guru dapat membantu siswa dengan menyuruh mereka untuk benar-benar menggerakkan tubuh mereka mengikuti petunjuk yang ada di peta.

7. Guru membuka diskusi kelas yang akan dilaksanakan selama 7 menit.
8. Guru menunjuk satu kelompok untuk maju ke depan dan mempresentasikan hasil diskusinya.
9. Guru menanyakan pendapat kelompok lain.

<i>Pertanyaan</i>	<i>Hipotesis Jawaban Siswa</i>	<i>Tanggapan Guru</i>	<i>Hipotesis Tanggapan Siswa</i>
Berdasarkan petunjuk di atas, lengkapilah peta wisata Kota Makassar. Berilah nama pada label situs, bangunan, atau jalan yang disebutkan dalam petunjuk tersebut.	<ul style="list-style-type: none"> <li>Siswa menjawab dengan benar. <i>Siswa melabeli setiap lokasi yang ditanyakan dengan tepat sesuai dengan peta sebenarnya.</i></li> <li>Siswa menjawab dengan salah. <i>Siswa melabeli beberapa lokasi tidak pada simbol yang diberikan di peta, misalnya melabeli "Lapangan Karebosi" pada simbol jalan raya atau pada</i></li> </ul>	Menanyakan kesulitan yang dialami siswa saat melengkapi peta.	<ul style="list-style-type: none"> <li>Siswa mengalami kesulitan membayangkan diri mereka bergerak di peta.</li> <li>Siswa terkadang kebingungan mengikuti instruksi yang diberikan.</li> </ul>

	<p><i>tempat kosong di peta di peta</i></p> <p><i>Siswa mengalami kebingungan ketika mengorientasi diri mereka pada peta yang mengakibatkan mereka berbelok kearah yang tidak tepat.</i></p>		
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10. Guru bersama dengan siswa membaca ulang petunjuk dan mengecek jawaban bersama-sama.
11. Guru menanggapi kesulitan-kesulitan yang dialami siswa dan memberikan saran-saran yang dapat dilakukan siswa untuk mengatasi kesulitan tersebut.
12. Guru melanjutkan pembelajaran ke kegiatan 2.

**Kegiatan 2 (30 menit): Membuat Itinerary Perjalanan Study Tour di Kota Makassar**

Kegiatan 2 memberikan kesempatan kepada siswa untuk mengatur rencana perjalanan study tour di kota Makassar selama 1 hari. Siswa diharapkan untuk mempertimbangkan semua hal-hal penting seperti tempat-tempat yang menarik, Masjid, tempat makan, dan lain-lain. Oleh karena itu, siswa diharapkan dapat menggunakan kemampuan spasial mereka dalam menemukan rancangan terbaik mereka.

1. Guru menjelaskan kegiatan yang akan dilakukan siswa.
 

“Kegiatan selanjutnya adalah kalian akan membuat rencana perjalanan di kota Makassar selama 1 hari. Kalian harus mempertimbangkan banyak hal-hal penting dalam perjalanan ini, seperti tempat-tempat yang menarik, tempat ibadah, tempat makan, dan lain-lain. Rancangan terbaik dari kelas kita, akan direkomendasikan untuk digunakan oleh siswa kelas 6 selama study tour

mereka nantinya. Kalian bisa membuat jawaban yang berbeda-beda namun kalian harus memiliki alasan yang bagus dan penjelasan untuk rencana yang kalian buat’

2. Guru memberikan waktu 20 menit kepada siswa untuk menyelesaikan soal dan berdiskusi dengan kelompok masing-masing.
3. Guru membagikan LKS.

<i>Pertanyaan</i>	<i>Hipotesis Jawaban Siswa</i>
Buatlah rencana bagaimana kalian akan menghabiskan waktu di Kota Makassar selama 1 hari. ( <i>Pertimbangkan semua hal-hal penting, seperti tempat menarik, Musholla, tempat makan siang, dan lain-lain</i> )	<ul style="list-style-type: none"> <li>• Siswa menggambar garis pada peta yang menunjukkan arah yang akan mereka lewati.</li> <li>• Siswa memiliki rencana yang berbeda-beda.</li> </ul>
Jelaskan arah yang kalian pilih untuk perjalanan kalian dari titik awal sampai titik akhir perjalanan kalian. ( <i>Kalian dapat menggunakan arah mata angin atau sistem navigasi (kiri, kanan, depan, belakang)</i> )	<ul style="list-style-type: none"> <li>• Siswa menggunakan arah mata angin dalam menjelaskan rencana mereka.</li> <li>• Siswa menggunakan system navigasi dalam menjelaskan rencana mereka.</li> <li>• Siswa menggabungkan arah mata angin dan system navigasi untuk menjelaskan rencana mereka.</li> <li>• Siswa menggunakan tempat dan nama jalan dalam menjelaskan rencana mereka.</li> </ul>

*Catatan:*

Tidak ada jawaban yang salah selama siswa dapat memberikan penjelasan atas jawaban yang mereka berikan.

4. Guru membuka diskusi kelas dan menyuruh setiap kelompok untuk menjelaskan rencana mereka beserta alasan mengapa mereka memilih rencana tersebut. (*10 menit*)

*Hipotesis jawaban siswa*

- Siswa memilih jalan terpendek dan melewati banyak tempat

- Siswa memilih rencana yang mengutamakan makan dan sholat tepat waktu.
  - Siswa memilih rencana yang memiliki durasi paling pendek.
5. Guru memerintahkan kelompok lain untuk mengikuti petunjuk dari kelompok presenter dan menanyakan apakah mereka dapat mengerti petunjuk yang diberikan.
  6. Guru menanyakan pendapat kelompok lain tentang rencana yang diajukan kelompok presenter apakah ada yang memiliki jawaban serupa.
  7. Guru menanyakan apakah ada kalimat yang perlu dibuat lebih jelas dalam petunjuk perjalanan yang dibuat oleh siswa.
  8. Guru menekankan bahwa dalam membuat rencana perjalanan, siswa harus mempertimbangkan kalimat yang digunakan apakah sudah jelas atau tidak sebab rencana ini nantinya akan digunakan oleh orang lain.

**Penutup (2 menit)**

Guru merefleksi pembelajaran dengan menanyakan: Apakah yang telah kita pelajari? Apakah manfaat dari materi yang kita pelajari?



## **THE IMPROVED HLT USED IN CYCLE 2**

### **Lesson 1: Using Cardinal Directions in Playing Scavenger Hunt**

#### **Learning goal**

1. Students indicate a direction using cardinal directions.
2. Students are able to read the simple map
3. Students are able to find a location in maps (their own location and location of objects)

#### **Classroom culture**

During the lesson, teacher gives chances for students to express their idea and opinion. Students should be stimulated to discuss and react to what others say since during the teaching and learning process students should work in team work.

#### **Description mathematical activity**

This set of activities offers an opportunity for students to discuss how they determine cardinal directions, see how this idea related to their daily life and apply this knowledge along with their spatial ability in solving problems.

#### ***Activity 1***

First activity is as warming up in which the teacher asks the students to utter everything they know about cardinal direction.

1. Teacher asks students to close their eyes and point the north.

#### *Conjecture of Students' Answer*

Students will point different directions. Some students point the wrong direction. Some students point the right direction.

2. Teacher asks students what their reason point the direction.



Conjecture of Students' Answer	How to respond
Students point to direction in front of them because they think that north is always in the front of them	Teacher should ask provocative question such as, <i>"If you are sitting on the seat in the 2<sup>nd</sup> grade's classroom, your north will be the opposite direction of your north right now. What do you think about that? Do the cardinal directions always change based on your body position?"</i>
Students know the north because they have done this in the previous social class.	Teacher should ask other students' opinion whether they are agree or whether their friend's answer convince them
Students used building or room they recognize in the school as a base to determine the cardinal directions (e.g.: school's Musholla (place for do prayer) as a base since commonly in Indonesia it faces qiblat (west))	<ul style="list-style-type: none"> <li>Teacher should give reinforcement to the students' answer</li> <li>Teacher should ask whether there are more buildings or objects which can be used to indicate cardinal directions</li> </ul>

3. Teacher continue to ask the students a question about how to convince other people that the direction we point is correct. For instance:

"What can we use to be sure that the direction we indicate is the right direction?"

Conjecture of Students' Answer	How to respond
<ul style="list-style-type: none"> <li>Students mention the Sun</li> <li>Students explain that the Sun rises in the east and sets in the west</li> </ul>	<ul style="list-style-type: none"> <li>Teacher gives reinforcement and asks the students for further explanation.</li> </ul>
Students mention magnetic compass.	Teacher gives reinforcement and asks the students for further explanation.

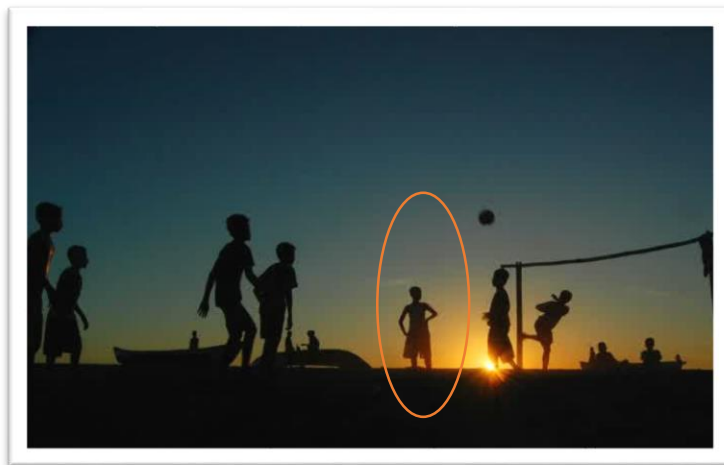
4. Teacher gives short responds to the students' answer (use of landmarks and the Sun's position).

**Activity 2**

The second activity the students are offered an opportunity to use the Sun's position to determine cardinal directions.

1. Teacher recall students' answer in the previous section about indicating cardinal directions by using the Sun's position.
2. Teacher shows a picture of children standing in the field. They backs the Sun. At that time the Sun is setting.
3. Teacher describe the problem related to this context.

“Last weekend, I took picture of children in the field near my home. I took a picture of them playing football while the Sun sets. One of the boy stood backs the Sun. Here are the pictures I took when I was there. What do you think from the picture which could help us to indicate the cardinal directions? Can you figure out in which direction the direction they were facing to? What direction in their left and right side?? Discuss this in your group.



4. Teacher shows the pictures in the story.
5. Teacher gives students the worksheet (see Appendix F)

*Students' worksheet:*

Look at the pictures. The picture was taken when the Sun sets. One of the boy stood back the Sun.

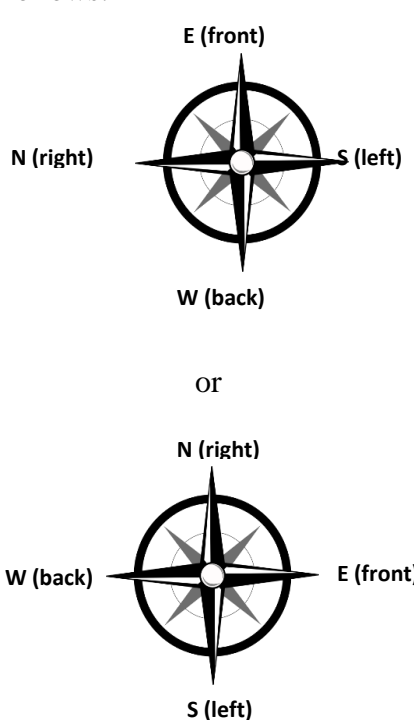
1. Now, can you figure out in which cardinal direction the boy is facing?

Explain your reasoning!

2. What direction in his left and right side?

3. Make the sketch of the cardinal directions the boy faced.

6. Teacher asks students to discuss the problem with their group.

Questions in the worksheet	Conjecture of students' answer	How to respond
Number 1	The boy faces the east. Because the boy stood back the Sunset which is west, so he faced the east	<p>When the students face difficulties in answering the questions, teacher could scaffold the students by asking the question as follows:</p> <ul style="list-style-type: none"> <li>• Do you know where the Sun sets and rises?</li> </ul> <p>Teacher could help by showing the picture once more in front of the class and re-explain the situation/context.</p> <p>Encountering the different answers, teacher should bring all the answer into the whole class discussion to lead students to the correct answer and realize their mistakes</p>
Number 2	In his left side is South and his right side is North.	
Number 3	<p>They make correct sketch, as follows:</p> 	

Questions in the worksheet	Conjecture of students' answer	How to respond
	Students make a wrong sketch such as reversing position between east and west or the left and the right side.	

7. Teacher asks students to share their idea and other students are given chance to give questions.

### **Activity 3**

This set of activities offer students an opportunity to apply the ability they acquire in the previous meeting. They will play a game called *Scavenger Hunt*. The students are asked to find some objects and give sign on the position of objects on the map based on the given clues.

1. Teacher informs the students that in this section they will play a game by using map.
2. Teacher explain the rule of the game to the students.
  - Students should solve the problems by discuss it within their group.
  - Students need to find five objects which are put in certain locations in the school by using map of the school.
  - Students need to find the object based on their turn.
  - In some location, there will be other objects which are not the the evidence.

- Students need to go outside the classroom to find the position of objects.
  - The list of objects and their positions will be given in the instruction sheet.
  - Before finding the object, students need to solve the first problem which is determining the cardinal directions in map.
3. Teacher gives the map for each group of students as well as the clues of the position of each objects.

Gerbang utama sekolah

Pos



Taman Sekolah

SD Inpres  
12/79  
Arasoe

Tempat  
parkir

Lapangan Sekolah

Kosong

R. Sholat

Kelas II

Kelas I

R. Guru

R. Kepala  
Sekolah

Kelas III

Kelas IV

Kelas VI

Toilet

Kelas VA

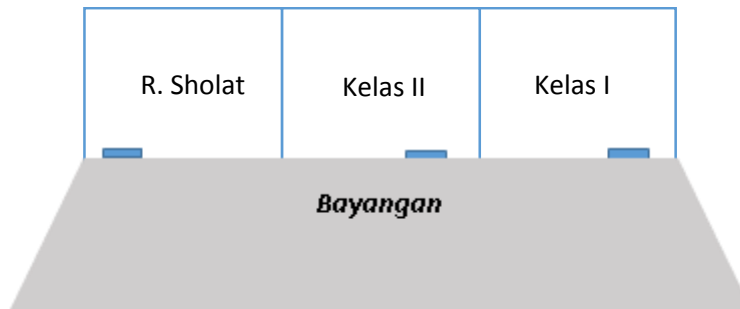
Kelas VB

Perpustakaan

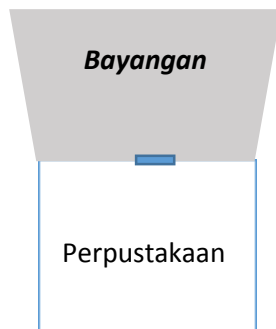
**DENAH SD INPRES 3/77 ARASOE**

**Instructions**

In the dawn, the classroom building shadow is as follows:



When the Sun sets, the shadow of school's aula is as follows:



**Object 1:** From your position right now, go out and go straight to the north and turn right. You will find the class IV building is in the eastern side of the object 1 and the class VA building is in the southern part of object 1

**Object 2:** Stand in front of class IV and walk to the east, you will find object 2 situated exactly in the south of “Ruang Sholat” and in the north of Class II building.

**Object 3:** From in front of *ruang sholat*, face the west and go straight. When arrive in front of class VI, go to the south and object 3 is in front of the room in north of Class VA.

**Object 4:** Stand in front of Class VB building and walk to the south until the end of the *lapangan sekolah*. Then, go straight to the east. You will find object 4 in the north of the main gate.

**Object 5:** From the main gate, go to the west and turn right when you see library in front of you. Object 5 is in the north of the library and in the south of class VA building.

Questions:

- 1) Determine the cardinal directions of the map
- 2) Find the location of objects and give a cross sign (X) in map
- 3) Draw the route you take to find all the objects

*Conjecture of students' answer:*

<b>Questions in the worksheet</b>	<b>Conjecture of students' answer</b>	<b>How to respond</b>
Number 1	<ul style="list-style-type: none"> <li>Students determine cardinal directions correctly. Students read the instruction carefully and complete their compass rose.</li> <li>Students determine cardinal directions incorrectly by directly putting the north in the upper part of the compass rose. It can be caused by not reading the instruction carefully or the students have an understanding that north is always in the upper part of the map.</li> </ul>	Teacher should explain the instruction before handing the worksheet to the students. In addition teacher could re-explain it when the student are discussing in group.
Number 2	<ul style="list-style-type: none"> <li>Students mark the position of objects correctly. Students have a correct compass rose and could follow and understand the instruction</li> <li>Students mark the position of objects incorrectly. Students could make mistake while following the instruction or there is something wrong with their compass rose or probably they make mistake in determining the left and right side on the map.</li> </ul>	In this case, teacher needs to pay attention to the students' answer and the way they determine the relative systems (left and right)



Questions in the worksheet	Conjecture of students' answer	How to respond
Number 3	<ul style="list-style-type: none"> <li>Students draw the route they take by drawing lines and arrow based on their answer in number 2.</li> <li>Students draw lines without arrow.</li> </ul>	Teacher should emphasise that the route they draw should be understandable and readable by others (it can be follow by other people)

4. Teacher shows larger picture of the map in front of school.
5. Teacher opens class discussion about students answer.
6. Teacher asks each group to mark the position of objects on the larger map.
7. Teacher asks the students to discuss the differences among the answers
  - Why do you think your answers are different?
  - Do you find it difficult to find the object? Why?

*Conjecture of students' answer:*

- Students realise some answers are wrong.
  - Students find it difficult since they cannot imagine where exactly the position in the maps.
  - Students make mistakes in determining the cardinal directions.
8. Teacher responds students' answer and emphasis that relative systems and cardinal directions are very helpful. In addition, the students need to pay attention to the relative system which is sometimes confusing since it is relative based on the speaker's position.

9. Teacher explains that students can use different ways to give directions, including using cardinal directions (based on the Sun's position and magnetic compass), relative systems, use of landmarks, or combination of them.
10. Closing the lesson

Teacher reflects the lesson by asking some questions:

- What do we learn?
- What do you think the benefit of playing this game?

## **Lesson 2: Constructing a mental map of Arasoe**

### **Learning goal**

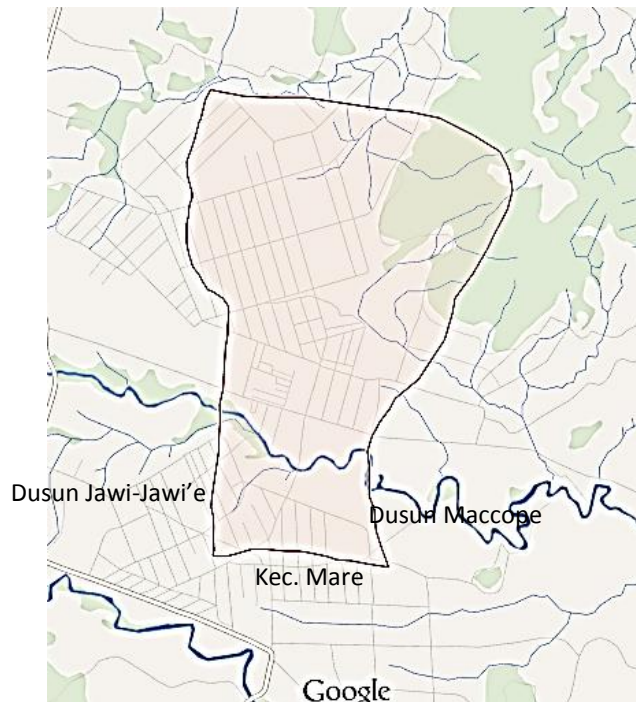
1. Students have general idea about the map of the village they live.
2. Students are able to identify locations on a blank map.
3. Students are able to apply their spatial skills to solve problem

### **Description of mathematical activity**

#### ***Activity 1***

This activity offer students the opportunity to construct their own mental map of the village hence the students have general idea of the map of Arasoe. In this activity, students are required to use their knowledge and their experience to fill in the name of place in the blank map of the village.

1. Teacher shows the map of Arasoe in front of the class.



2. Teacher asks the students whether they recognize the map.

- Is there any of you recognize what map is this?

*Conjecture of students' answers:*

- 1) Students do not recognize that it is the map of Arasoe.
  - 2) Students recognize it is the map of Arasoe because they have seen it in the social class
  - 3) Students recognize it is the map of Arasoe because some students have been in the village office.
  - 4) Students recognize it is the map of Arasoe because they see other villages nearby on the map.
3. Teacher tells the students that it is the map of Arasoe.
4. Teacher explains that in this meeting they are going to explore the map of their village.

5. Teacher hands the blank map of the city.
6. Teacher asks the students to make group of four children.
7. Teacher hands the worksheet in.
8. Teacher asks each group to discuss and give the name of the areas or spots in map as many as they could recognize as well as the reasoning of their answer.

*Conjecture of students' answers:*

- 1) Students know some locations in the map because they ever saw it on the map before.
- 2) Students find some locations in map by using the information given in the map, such as the position of other villages and the cardinal directions.
- 3) Students do not spot any location of places on the map.

(Teacher tells them to pay attention to the other villages' position and ask students whether they know the place near those villages. Moreover, teacher could stimulate students' reasoning by pointing the one village in the map and ask the students what place in Arasoe near that village. In addition, teacher asks the students to remember the previous lesson using map of the school. Because students already familiar with the cardinal directions in school, they could help the students to use that knowledge to help them)

9. Teacher asks two or three groups to present what they discuss.
10. Teacher asks other groups whether they have questions or remarks to their fellow students' discussion.

11. Teacher asks additional question about the location of some landmarks in Arasoe.

- Could you find where the positions of Pabrik Gula Bone, Traditional Market, Masjid Makmur, the cane field, and your school?

*Conjecture of students' answer:*

- 1) Students find out all the landmarks by using the information they have in the number 1.
- 2) Students have difficulties in finding the landmarks which could help them to find other locations.

(In this case, teacher could help the students by giving the position of other places near by the landmarks)

12. Teacher shows the blank map with the answers of the students and compare it with the original map of the village.

13. Teacher opens discussion about the location of places found by students to check whether they locates them correctly.

14. After labelling the map of the village, teacher asks students to divide the area in the map of the village respect to cardinal directions.

*Conjecture of students' answer:*

- Students divide the map respect to the cardinal directions

15. Teacher asks students' difficulties in identifying locations on map.

*Conjecture of students' answer:*

- Students find it hard to orientate a position by merely using map.
- Students are not familiar with the village yet.

16. Teacher opens class discussion.
17. Teacher asks students to explain their answer and how they get them in order to help other students who still find it difficult to interpret the map.
18. Closing the lesson: Teacher reflects the lesson by asking some questions:
  - What do we learn?
  - What do you think the benefit of this activity?

### **Lesson 3: Exploring the Map of the Unfamiliar Place**

#### **Learning goal**

1. Students are able to find location on the map and understand symbols used on the map.
2. Students are able to find the most efficient way to get around in unfamiliar place
3. Students are able to apply their spatial skills to solve problem

#### **Classroom culture**

Teacher gives chances for students to express their idea and opinion. However, students should raise their hand if they want to express their opinion and ask questions. In this meeting, the students should work in team while solving the problem.

#### ***Activity 1: Completing the Tourist Map of Makassar***

#### **Description of mathematical activity**

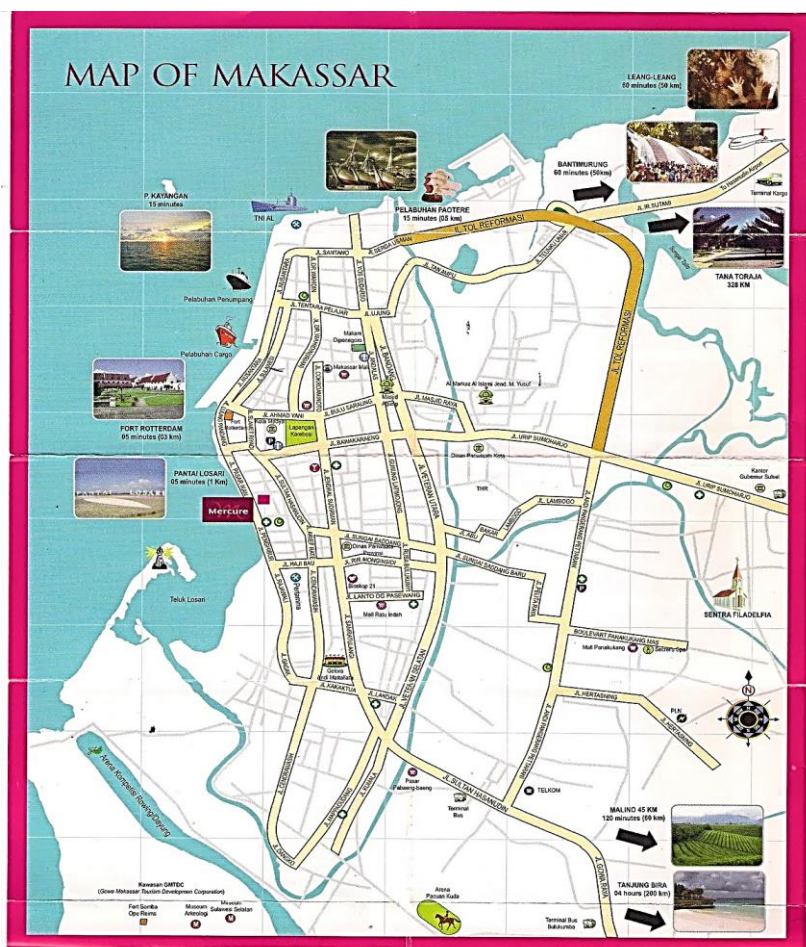
In this activity the students are required to complete the tourist map of Makassar by naming the buildings, sites, or streets which have been labelled. The

instruction given will use both cardinal directions and relative systems. Therefore, in completing the task, students will apply their spatial orientation.

1. Teachers explain what students will do in this activity.

Class 6 plan to have three days study tour to Makassar and Malino. The headmaster's colleague working in Tourism Agency helps us to arrange the tour. He gave us the tourist map of the city and the instruction. However, the map is not complete, many labels are missing. Now, use the given instruction to complete the tourist map of Makassar to make your class' study tour easier.

2. Teacher gives the map as well as the instruction for each group of students.
3. Teacher told the students to read the instructions sentence by sentence.



**Instructions**

From Bone, you will pass Bantimurung. Go straight until you find “Tol Reformasi”. In the north side of the street you can see the “Pelabuhan Paotere”. Then you will find cross road, turn left to “Jl. Yos Sudarso”. Go straight to the “Jl. Andalas”, in your left you will see a “church”. In the north of the church, you will see “Makam Diponegoro”. Go straight until you find Masjid Agung. Then, turn left to “Jl. Bulu Saraung”. Go straight to “Jl. Ahmad Yani”, “Lapangan Karebosi” is in the south of the street. Go straight until you find the sea and go to the south, “Jl. Ujung Pandang”. In the west of the street you will see “Fort Rotterdam”. Continue your journey along the shore. You will see “mercure” in the east of the “Jl. Pasar Ikan” as well as “Hospital 1” and “Masjid” in the south of the mercure. Go straight to “Jl. Gagak” and turn left to the “Jl. Kakatua” in which a famous *Coto* restaurant situated. In the north of Jl. Kakatua, you will see “Gelora Andi Mattalatta”. Then, turn right and “Hospital 2” is in your left. Continue to go straight and after passing the cross road, in your right, you will firstly find “Pasar Pabaeng-baeng” then secondly a “Terminal Bus”. Continue your journey to the southern part of the city, after 2 hours, you will reach Malino.

**Questions:**

Based on the instruction above, find the sites, buildings, or the streets which are mentioned in the instruction



*Conjecture of students' answer:*

- Students answer the question correctly because they understand and could follow instruction using cardinal directions easily.
  - Students answer the question incorrectly because they make mistake in their compass rose.
  - Students answer the question incorrectly because they make mistake in orientating their body while moving on the map (make mistake in determining left and right).
4. Teacher opens classroom discussion about students' answer.
  5. Teacher asks students' difficulties while solving the problems.

*Conjecture of students' answer:*

- Students might find this problem difficult since it is hard for them to imagine themselves moving in the city.
- Students might get confused in following instruction and understanding the map.
- Students find it hard to indicate the exact locations on the map.

In facing this situation, the teacher could ask the students to really move their body based on instruction instead of just imagining it in their head. The teacher also could ask other students to re explain the situation and help their counterpart to understand the instruction.

6. Teacher then continue the class to the second activity.

**Activity 3: Planning an itinerary**

This set of activities offer students an opportunity to arrange a plan go around Makassar in a day. They need to consider the important things, such as the attraction, Musholla, place to have lunch, etc. Therefore, they need to make sense all information on map and plan a scenario for that. In this activity, students are required to apply their spatial orientation to find the solution.

11. Teacher informs the activity which students are going to do in this activity.

12. Teacher explain what students should do.

- Students plan a way in go around the city of Makassar.
- Different ways are allowed as long as students have good reason and explanation for that.
- Students need to consider all information on the map.

13. Teacher gives the worksheet.

**Questions**

- 1) Make a plan how you will spend your day in the city. (*Mind all important aspects such as the attraction, Musholla, place to have lunch, etc*).
- 2) Explain the direction from your starting point to the end point. (*You may use cardinal directions or the relative systems*)

14. Teacher ask the students to present their answers.

Questions in the worksheet	Conjecture of students' answer	How to respond
Number 1	<ul style="list-style-type: none"> <li>• Students draw the line in the map which represent their way to go around the city.</li> </ul>	Teacher should know that there are no wrong answers for this questions as long

Questions in the worksheet	Conjecture of students' answer	How to respond
	<ul style="list-style-type: none"> <li>Students come up with different solutions and reasons.</li> </ul>	as the students could give the explanation and reason for their answers.
Number 2	<ul style="list-style-type: none"> <li>Students give direction by using cardinal directions only to explain their way</li> <li>Students give directions by using relative systems only to explain their way</li> <li>Students combine cardinal directions and relative systems to explain their way</li> <li>Students use landmarks to explain their way</li> <li>Students combine cardinal directions, relative systems, and landmarks</li> </ul>	

15. Teacher pastes larger map in front of the class.

16. Teacher asks one group to complete the map based on their group work in the board.

17. Teacher then opens class discussion for the question 1

18. Teacher asks students to explain their solution and the reason why they choose it.

*Conjecture of students' reasoning:*

- The students choose the places they have interest with for instance for who like history, they choose museum and historical place or for who likes sport, they prefer go to see stadium and *lapangan* Karebosi.
- The shortest distance in go around the city, but visiting most of the famous sites

- They still have their lunch in restaurant and pray in Musholla on time.
- It needs shortest duration.

19. Teacher asks one or two groups to explain their plan to get around the city and ask other group whether they could follow the instruction made by those groups.

20. Teacher open classroom discussion to revise (if needed) each groups' answer, such as the chosen words or sentences in giving direction whether they are clear enough or no.

21. Closing the lesson

Teacher reflects the lesson by asking some questions:

- What do we learn?
- What do you think the benefit of this activity?