SIXTH GRADE INDONESIAN STUDENT EXPLANATIONS OF DIRECTIONS ON FLAT MAPS AND GLOBES, OF THE EARTH'S ROTATION TO CAUSE NIGHT AND DAY, AND OF THE RELATIVE POSITIONS OF THE EARTH, MOON, AND SUN DURING AN ECLIPSE

by

Surachman Dimyati

An Abstract

Of a thesis submitted in partial fulfillment
of the requirements for the Doctor of
Philosophy degree in Education
in the Graduate College of
The University of Iowa

May 2001

Thesis supervisor: Associate Professor John T Wilson

ABSTRACT

The purpose of the study was to elicit and analyze sixth grade students' explanations concerning concepts taught in the national Indonesian sixth grade science curriculum. In this study, students were asked to identify the cardinal directions on flat maps and a globe, to describe what causes night and day on the earth, to identify the direction of the earth's rotation, and to identify the relative positions of the earth, sun, and moon during either a solar or lunar eclipse.

The findings in the study can be summarized as follows:

1. Eighty out of 88 students (91%) were able to explain what causes night and day.
2. Approximately 50% could identify the direction the earth rotates to cause night and day.
3. Using a solar system model, about 64% of the students could describe the relative position of the earth, sun, and moon during an eclipse.

4. Cultural differences affect student thinking. One student thought that Mecca had to be west of everywhere, not just west of Indonesia.
5. The way teachers teach seems to influence student thinking. It is easy for students to form the misconception that up is north. Most maps in classrooms are hung vertically.
6. Some students were confused by the globe. Teachers need to explain why the globe is tilted. Also, they need to help students understand how to determine the cardinal directions on a globe.

More research is needed to determine what is needed to help students truly understand these concepts and to determine whether these concepts are best taught at the elementary level.

Abstract approved: _____
Thesis supervisor

_____
Title and department

_____
Date

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Iowa City, Iowa

CERTIFICATE OF APPROVAL

PH.D. THESIS

This is to certify that the Ph.D. thesis of

Surachman Dimyati

has been approved by the Examining Committee for the thesis requirement for the Doctor of Philosophy degree in Education at the May 2001 graduation

Thesis committee:

Thesis supervisor

Member

Member

Member

Member

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CHAPTER I

INTRODUCTION

Purpose of the Study

The purpose of this study was to elicit and analyze sixth grade Indonesian students' ability to identify the cardinal directions (north, south, east, and west) on a flat map and a globe; their ability to explain the earth's rotation as it relates to night and day; and their ability to identify the relative location of the earth to the moon and sun during either a solar or lunar eclipse. All of these skills and concepts are taught as part of Indonesia's national elementary science curriculum (i.e., the National Standards of Indonesia).

Understanding the cardinal directions (north, south, east, and west) is very important in clearly explaining the astronomical concepts being investigated.

Beside the four cardinal directions, the study documented students' explanations of the following two main concepts:

1. Night and day are caused by the earth's rotation on its axis.

a. It takes 24 hours for the earth to rotate once.

b. The earth rotates towards the east.

c. The sun is located behind the earth during the night.

2. Eclipses

a. The moon revolves around the earth and at the same time both of them are also revolving around the sun, therefore in certain positions an eclipse occurs.

b. A lunar eclipse occurs when the sun, the earth and the moon are located in a straight line causing the moon to be covered by the earth's shadow.

c. A solar eclipse occurs when the sun, the moon and the earth are located in a straight line causing the light from the sun to be blocked by the moon.

This study seeks to illuminate the following research questions:

1. Can students identify the cardinal directions (north, south, east, and west)?

a. on a flat map?

b. on a globe?

2. Can students identify what causes night and day?

a. Can they explain that night and day is caused when

the earth rotates on its axis?

c. Can they show which direction the earth rotates?

d. Can they tell how long it takes for the earth to complete one revolution?

e. Can they explain/identify where the sun is during the night?

3. Using an Eclipse Model, can students explain/demonstrate the location of the earth, sun, and moon during either a solar or lunar eclipse?

4. What misconceptions were demonstrated in terms of the scientific concepts investigated in this study?

Overview

Many children around the world find it difficult to understand science concepts as taught in schools. A steadily growing body of research has promoted a remarkable and problematic picture of student understanding of scientific concepts (Driver, 1983, 1989; Driver & Oldham, 1986; Linn, 1987).

Students face difficulties in formal teaching of concepts when children are not at a formal stage of reasoning and they need to see concrete models or handle actual objects to truly understand. Nelson (1991) stated an

implication of Hall's study was that children are never completely free from misconceptions. Hall's stated appreciation for the "content of a child's mind" was, at best, limited. Following an investigation into children's ideas about fire, Hall described the conception of the sun held by children as "utterly brutish and hopeless" (Hall & Browne, 1903, p. 78). This low estimation of children's power of explanation and interpretation led Hall to advocate the "Nature Study" approach in elementary school science with its emphasis on naming and "object" lessons. According to Smith (1963), Hall indicated that, intellectually, a child should be "considered in terms of his limitations rather than in terms of his capabilities" (p.202)

Nelson cited the studies done by Keuthe (1963) and Rogers (1961), employed large item inventories, requiring written responses, to gauge the level to which high school and college students held misconceptions concerning physics and biology concepts. Both studies identified the specific concepts and natural phenomena that presented the greatest difficulties to the respective age groups. These authors lamented the level of misunderstanding exhibited by these students and suggested that these misconceptions were a result of "memorization that was rote and not in the

framework of a logically meaningful system". (Nelson, 1991, pp.21-22)

Studies have indicated that individuals construct informal theories that they use in explaining a wide range of natural phenomena. Often these informal theories have been referred to as misconceptions (Helm & Novak, 1983), alternative frameworks (Driver, 1981), preconceptions/prior knowledge (Hewson, 1982), or children's science (Gilbert, et al., 1982). The terms "alternative conceptions" and "alternative frameworks" were used in this study. This was based on the assumption that prior knowledge is not likely to be considered a misconception by the constructor of the knowledge, but may often be viewed as a misconception by another evaluator. Alternative conceptions have been found to be prevalent in students at various grade levels despite formal teaching in schools. Alternative conceptions that students hold reflect a lack of formal instruction or an inadequacy in the science instruction or curriculum to overcome the students' faulty but self-constructed concepts. Students bring existing, and often misconceived, knowledge of science concepts to the classroom and many teachers are not aware of their student's perspectives nor are they aware of effective ways of handling them (Adenity, 1985). The

student misconceptions influence how and what they learn. Rather than creating new information and understanding, existing concepts must be replaced or modified. Thus students' prior ideas about science concepts should be significant to practicing teachers and curriculum developers.

This study used an interpretive approach to examine the children's concepts of directions and astronomical understandings as stated above.

Overview of the Study

The study was done in the city of Bangkalan. The city is located less than twenty miles north of Surabaya, the second largest city in Indonesia. A small sample of approximately 100 students was used. Resources were not available to study all sixth grade students in Indonesia, a total of approximately 3.3 million (Badan Penelitian dan Pengembangan Pendidikan dan Kebudayaan, Pusat Informatika, 1992). Although the city selected in this study is only one city, five different locations were selected from the general make-up of the community to give a broad base sample.

The scientific concepts selected to study were in the

main part picked because they are normally taught at a time in the year just prior to when the interviews were conducted. Thus, the concepts should have been relatively fresh in the students' minds and long-term memory loss should not have been that great of a factor. In this study each student was interviewed twice during a two-week period. The first interview relied solely on verbal interactions with the exception of limited sketching done by some of the students. In the follow-up interviews, a globe, a flat world map, and an eclipse model played an important role. In the second interview students manipulated the models, as they tried to demonstrate the key concepts related to the cardinal directions, the earth's movements and solar/lunar eclipses.

Individual interviews are widely accepted as a means to probe children's ideas about science concepts. Misconceptions were identified by comparing student ideas to those presented in the national curriculum.

This study is exploratory in nature, the goal being to identify possible disconnects in what is intended in the teaching of the curriculum and what is actually learned. This study was not an attempt to sample the total population of sixth grade students in Indonesia. Due to limited

resources, only an isolated sample of ten schools from one Indonesian city could be used. In no way, should one generalize from this small sample to the total national population. The main goal was to get an idea of how well students are able to explain and demonstrate the concepts and skills they had just studied in their science curriculum. The researcher himself executed the interview process. The researcher, a native Indonesian, is very familiar with Indonesian elementary students and school settings.

The Condition of Indonesian Elementary Schools

Indonesian public schools (grades 1-6, 7-9, and 9-12) use a national curriculum. Kindergarten classrooms are usually managed as private schools separate even from elementary schools. Schools follow a national curriculum provided by the government.

In the elementary national curriculum every student studies ten main subjects; an eleventh (e.g., local dialect) is optional in some areas. These subjects are:

1. Religion (Four main religions are: Islam, Christianity (Catholic/ Protestant), Hinduism, and Buddhism are

usually made available on a voluntary basis to students);

2. Pancasila Ethical Education (Pancasila is national philosophy composed of five basic principles);
3. Civics and National History;
4. Bahasa Indonesia (Indonesian Language);
5. Social Studies;
6. Mathematics;
7. Science;
8. Physical Education;
9. Arts;
10. Basic Skills (e.g., vocational skills); and
11. Local Dialect. Local dialect in some big cities is an optional curricular area.

A spiral curriculum is implemented in Indonesia. For example, the solar system is formally studied in sixth grade and again in the seventh grade and electricity and magnetism are studied in the sixth grade and again in the ninth grade.

Most public schools in Indonesia have very limited funds. Their facilities may differ slightly from one school to the next, but the curriculum is essentially the same. There are minor differences in public schools due to parental and community support which influences school

funding, but it is assumed this will not have a big effect on school achievement.

At the end of 6th, 9th, and 12th grades, students take national standardized tests. These tests are given to measure the degree to which student achievement matches the curriculum goals. The tests cover the concepts taught during the previous grades. Most of the tests are objective tests. The results of the tests are used as screening tools for admission to the next level. Students who get a better grade will gain admission to a "better" school. These tests, which stress content rather than process skills, encourage administrators and teachers to develop teaching strategies, situations and conditions that support student achievement. For example, teachers tested students orally for topics they have been taught on a daily basis. At the end of these tests teachers provide the correct answers, so students memorize the correct answers for specific questions. Therefore, the implementation of the current curriculum and teaching methods tend to be dominated by strategies that emphasize factual and knowledge learning rather than process skills. Schools compete for high scores. Since the general criteria for measuring a "good school" is dependent on the number of students who get high scores, teaching processes tend to

emphasize drill rather than provide experience related to the relevant process skills of science.

Although the curriculum (symbolic curriculum) formally emphasizes the development of scientific process skills, in the real world (experienced curriculum), the focus is on content or factual knowledge. With about forty students in each class, lecture is the method used by most teachers. The methods and materials used are also related to public opinion. The community rates the school based on how well students achieve on the national examinations. The higher the average scores in the national tests the higher the public rates the schools. As students move to junior high, and then to senior high, and finally to college a good test score will open the door for the student to a good school. This issue also encourages teachers to give additional tutoring out of school. In some cases this private tutoring is a way for teachers to supplement their income. The parents pay extra tuition for teachers for this tutoring. Some schools also provide general tutoring for all students to prevent complaints from parents who cannot afford to pay for private tutoring. Private tutors for every level are available, especially in big cities. In Bangkalan, the city where this study took place, a general free tutorial program

for sixth graders is provided in every school.

This study sought a comprehensive understanding of sixth grade student explanations of the four cardinal directions, the earth and related phenomena that is covered in the national curriculum (adopted in 1994). The national curriculum is implemented in all the public schools thorough out the country of Indonesia.

Significance of the Study

In the elementary national curriculum, adopted in 1994, science subjects are introduced from third grade to sixth grade. The earth and its related phenomena, the focus of this study, are taught in the last four months of the sixth grade.

The instructional objectives of the 1994 sixth-grade Indonesian science curriculum related to the solar system deal with the movement of the earth and the location of the earth, sun, and moon during lunar and solar eclipses. (Departemen Pendidikan dan Kebudayaan Republik Indonesia, 1995. p. 86)

The results of this study will provide information that could be of help to the Indonesian government, administrators, education faculty, teachers, and textbook

writers.

This study will also add to the growing international research literature on understanding the misconceptions of elementary students regarding scientific concepts.

Furthermore, if concept learning can be improved at the elementary school, students will have a better base to understand the abstract learning they will experience in junior and senior high school.

Understanding how the individual student acquires the specific concepts will help clarify individual learning strategies. This may suggest instructional strategies that could benefit teachers and students.

CHAPTER II

REVIEW OF THE LITERATURE

The review of the literature has been divided into six sections. They are discussed in the following order: 1. Qualitative Design, 2. Children's Concept Development, 3. Constructivist View of Teaching and Learning, 4. Misconceptions and Learning, 5. The Clinical Interview as a Method of Eliciting Children's Ideas in Science, and 6. Related Studies.

Qualitative Design

Creswell (1994) stated that the qualitative approach incorporated much more of a literary form of writing than the quantitative approach. However, he also suggested that in qualitative research the literature should be used in a manner consistent with the methodological assumptions, namely, it should be used inductively, so that it does not direct the questions asked by the researcher. One of the reasons for conducting a qualitative study is that the study is exploratory; not much has been written about the topic,

or population being studied, and the researcher seeks to listen to informants and build a picture based on their ideas.

Qualitative designs, as suggested by Creswell (1994), are unlike quantitative designs, few writers agree on a precise procedure for data collection, analysis, and reporting of qualitative research. (p. 143)

Kirk and Miller (1986) stated that to see qualitative research as strictly disengaged from any form of counting is to miss the point that its basic strategy depends on the reconciliation of diverse research tactics. (p.12) They also stressed that hypothesis testing is not the only research activity in any scientific discipline. Indeed, the most dramatic discoveries necessarily come about some other way, because in order to test a hypothesis, the investigator must already know what it is he or she is going to discover. (p.17)

Regarding the qualitative study, Merriam (1988) in Creswell (1994) mentioned a number of assumptions:

First, qualitative researchers are interested in meaning- how people make sense of their lives, experiences, and their structures of the world.

Second, the qualitative researcher is the instrument

for data collection and analysis. Data are mediated through this human instrument, rather than through inventories, questionnaires, or machines.

Third, qualitative research involves fieldwork. The researcher physically goes to the people, setting, site, or institution to observe or record behavior in its natural setting.

Fourth, qualitative research is descriptive in that the researcher is interested in process, meaning, and understanding gained through words or pictures.

Finally the fifth, the process of qualitative research is inductive in that the researcher builds abstractions, concepts, hypotheses, and theories from detail.

In anthropological nature, the researcher intends to be a "participant observer rather than a detached scientist manipulating, controlling, and measuring people and events" (Power, 1976, p. 258). Furthermore, this study demonstrates a philosophical commitment to the "children's science" perspective in which the interviewer "does not evaluate whether or not the child has an acceptable scientific concept, but simply attempts to establish what are the child's ideas" (Osborne & Freyberg, 1985, pp. 5-6).

Children's Concept Development

Regarding children's conceptual development, Vigotsky (1962) proposed three stages: thematic concepts, chain concepts, and true concepts. At the earliest ages, children form thematic concepts, which emphasize relations between particular pairs of objects rather than categorical relations. At the next developmental stage, preschool children form chain concepts. They classify things on the basis of some features, but often change from example to example. Thus the grouping lacks any single defining attribute. Later, in the third stage, children in elementary schools form true concepts, which are based on consistent sufficient attributes.

Chi (1991) proposed that young children categorize things on the basis of thematic rather than taxonomic relations because knowledge is not properly presented. Children's knowledge is contextually bound; it can only be accessed in one context and not another. Developmental changes in the overall structure of knowledge enable children to group things relying on taxonomic relations. Studies propose that concept learning through exemplars plays an important role in conceptual development, especially in younger children. Kossan (1981) reported 7-year-olds learned faster under conditions that have close

attention to specific examples than under conditions that need learning of a rule for classifying new examples. On the other hand, 10-year-olds learned well under both conditions. Kossan explained that the 7-year-olds were more correct in the example-based condition because it was closer to the way that they habitually learned. Since children may have difficulty when facing a really new object, they must have some basis of comparison beyond a simple match or not. Children have to develop important features and relations to represent concepts.

Many categories are hierarchical and can be considered at three levels; a general one (the superordinate levels), the specific one (the subordinate level), and one of middling generality (the basic level), (Rosch, 1976). For example, "bird" is a basic-level category; "animal" is a superordinate one; and "robin" is a subordinate one.

How do children acquire concepts at different levels of generality? There is no developmental trend for concept development in a specific to general progression or in a general to specific progression. Rather, the possible trend for concept development is that children first learn concepts at an intermediate level of generality and later learn more specific terms through differentiation and more

general terms through hierarchic integration (Aglin,1977). Basic-level categories play prominent roles in early conceptual development.

Other studies also revealed that children first learn category names for objects that are familiar and important to them in their daily lives and later learn labels for less familiar and less important objects (Aglin, 1977). This seems to agree with the finding that the frequency of occurrence is the determinant of the order of acquisition of category labels (Abdullah & Lowell, 1981). These researchers investigated the ability of elementary school students to generalize two science concepts, insect and animal, with and without instruction in the form of a mental set. They also found the effects of age, IQ, and sex on the ability of the children to generalize the concepts. The results revealed that age and mental set were significantly related to the ability to generalize the concepts insect and animal. It was found that with age these concepts became more developed and more conceptual in nature. The children in this study were more able to generalize the concept insect than the animal concept. The results suggest that children, with age and instruction, are better able to master a less general concept. The concept of insects is easier than the more

general one, animal. The study also showed that children were able to improve their ability to generalize a concept if instruction included a great number and variety of instances and non-instances of the concept.

Constructivist View of Teaching and Learning

In a constructivist point of view, learning is an active process of learners constructing knowledge based on their existing knowledge. Existing knowledge not only influences what is perceived in any situation but also influences how new experiences are interpreted. Hence, knowledge cannot simply be transmitted from teacher to students, but must be actively constructed by each student or learner in their own mind (Von Glaserfeld, 1991).

Furthermore, Lythcott and Duschl, (1990), stated many studies support the constructivist view that (1) children construct their own conceptions about natural phenomena, (2) these conceptions are often different from scientific ones, and (3) children are highly resistant to change toward real scientific views through additional teaching.

A number of studies suggest some strategies that could be helpful in promoting students' conceptual understanding:

First, providing opportunities for students to make

their existing knowledge explicit. In classrooms, students are encouraged to write down or discuss their ideas about science concepts.

Second, let students confront their existing knowledge, and find the inadequacy of their knowledge. Socratic questioning and peer discussion can help students understand their conceptual conflict, which may make students dissatisfied with their current ideas and hence see the need for new ideas,

And third, encourage students to generate a variety of conceptual schemes. When students find existing knowledge is inconsistent, they need to consider possible unifying ideas for science concepts or phenomena, evaluate these for themselves, and eventually reconstruct their ideas in a more coherent way.

Finally, have students practice the ideas in various of situations.

Meaningful conceptual understanding means that students can apply knowledge in new contexts and make links between concepts or knowledge (Driver, 1985).

Misconceptions and Learning

An essential conception of the constructivist view is that knowledge is actively constructed, and that this process draws on the existing knowledge of the students. Research shows that when teachers do not take students' preconceptions into account during instruction, students understand natural phenomena poorly (Anderson & Smith, 1986; Minstrell, 1984). On the other hand, when teachers learn and take into account how students' preconceptions contrast with scientific views, developing more accurate student understanding of the science concept improved dramatically (Anderson & Smith, 1986; Eton, 1983).

Not considering students' preconceptions may explain why what is learned is not always what the teacher expects students to learn. Bell (1984) used protocol analysis to investigate how students construct meaning when reading a passage about animals. She found that students integrate the concept of animal through a two-stage process. In the first stage they generate a meaning similar to the author's idea. In the second stage they evaluate the meaning and decide to either accept or reject the meaning. Problems can be encountered in either of the two stages. Because of their existing knowledge, some students could not create correct

meanings and did not seem aware of the inability.

Students rejected the intended meaning because they either:

1. did not see the need to change their prior knowledge or
2. did not find that the new meaning was more plausible based on their own experiences.

The findings support previous studies (Ausubel, 1978; Osborne, & Wittrock, 1983), which suggest that the existing knowledge of students played an important role in the interpretation and integration of the instructional material.

Adeniyi (1985) observed a teacher teaching ecology in junior high schools and found that part of the students' problems in learning a science phenomenon can be traced to their preconceptions. After instruction, the students were interviewed about the ecological concepts that the teacher taught in the classroom. The misconceptions were re-stated in the interviews. The students did not replace their preconceptions with what the teacher told them. Old ideas of students prior to instruction are resistant to change and have a profound effect on the understanding of new concepts and generalizations. Again, the existing knowledge of students prior to instruction persists, regardless of

instruction (Adeniyi, 1985; Hewson, 1982).

The Clinical Interview as a Method of Eliciting Children's Ideas in Science

The interview as a method of eliciting children's conceptions of natural phenomena and learning in science has won wide acceptance in science education research. While the use of systematic questioning in teaching (such as the Socratic method) has a long history, the interview, as a "professional conversation" (Posner & Gertzog, 1982) was initially developed for use by psychiatrists. Only within the last century has the interview (or clinical examination) become viewed as a tool of diagnosis and therapy. It was this clinical diagnostic technique, as adapted by Jean Piaget, which served as the interview model for much of the later science education research (Milkent, 1977; Novak & Gowin, 1984).

Piaget's development of what was to become known as the clinical interview was prompted by his dissatisfaction with tests and observations as a means of assessing "what conceptions of the world the child naturally forms at different stages of its development" (1929, p.1). Piaget concluded that while tests and observations had the same

merit, their shortcomings outweighed their benefits and that the clinical interview melded the best of both methods into a single form. For Piaget, the clinical interview, like a test, was enabling to experimental methods and, like an observation, offered the possibility for interpretation of the child's explanations.

In Piaget's conception of the clinical interview, the researcher begins with the child. When investigating explanations concerning a particular topic, the researcher utilizes questions framed from the comments of children. While the researcher supplies the overall framework of the inquiry, the questions are in the language of children. Piaget urged the use of the verbatim responses of children to avoid possible misinterpretation of their explanations.

In addition, care had to be taken when considering the nature of a particular child's explanations. Piaget offered five levels of explanation ranging from random to reasoned responses. The interviewer had to utilize caution when assigning value to any particular explanation, especially if that explanation may lead to generalizations about an individual or group.

The individual interview has become an accepted technique among those research workers investigating

children's ideas about natural phenomena. While interview procedures may differ from study to study, the goal of these interviews seems fairly consistent; that is, "to ascertain the nature and extent of an individual's knowledge about a particular domain by identifying the relevant conceptions that he or she holds and the perceived relationships among those conceptions" (Posner & Gertzog, 1982, p 195). With this unifying goal in mind, it is useful to consider how the individual interview has been used in several of the different research perspectives within the constructivist framework.

Some Related Studies

Previous studies with children's understandings of natural phenomena done by Driver and Erickson (1993) have shown that children do possess "invented ideas" based on experience "which influence the ways in which they respond to and understand disciplinary knowledge as presented in the classroom". Furthermore, it has been found by Driver and Easly (1978) that the identification of these ideas can raise the educator's "awareness of the possible perspectives" held by pupils and can facilitate "more effective communication" between the teacher and the

learner.

No more logical method exists to ascertain the complex of student conceptions, regarding a particular phenomenon, than to ask students for their explanations concerning that phenomenon. Individual interviews as "a method of observation, which consists in letting the child talk and in noticing the manner in which his thought unfolds itself" (Piaget, 1926, p. xiii) have proven a most effective strategy for eliciting such explanations. They provide the desired degree of control for the researcher and at the same time cultivate the interview as a cooperative endeavor between the subject and the researcher (Kelly, 1969, p. 22).

While interview procedures may differ from study to study, the goal of the interviews is to "ascertain the nature and extent of an individual's knowledge about a particular domain by identifying the relevant conceptions he or she holds and the perceived relationships among those conceptions" (Posner & Gertzog, 1982, p. 195).

In the design of the current study, aspects parallel those of previous studies investigating children's conceptions concerning natural phenomena. These shared aspects include: (a) the use of individual interviews to elicit children's explanations, (b) the description of

individual explanations of children, and (c) the interpretation and categorization of those explanations.

Several studies have investigated elementary school children's ideas concerning the earth.

Nussbaum and Novak (1976) in An Assessment of Children Concepts of the Earth Utilizing Structured Interview was part of a continuing series of efforts to design and evaluate an audio tutorial science lesson. The teachers were asked not to supplement the instruction offered. The purpose was to eliminate the teacher as a source of uncontrolled variance in children's concept learning. The subjects were second graders of elementary schools in Ithaca, New York. The basic tasks common to nearly all the assessment items involved predicting directions of imaginary free fall occurring at different points on a model of earth and explaining the prediction.

Furthermore, Nusbaum (1979) in Children's Conception of the Earth as a Cosmic Body: A Cross Age Study studied subjects of grade 4 to grade 8 at elementary schools in Jerusalem, Israel. Instead of using open-ended interviews like in the previous study, he used a multiple-choice format. Each of the four alternative choices was presented with a drawing. He suggested that the interview method

should be utilized much more widely in both teaching and research for an assessment of the learning of many other specific science concepts. As was the case with the Earth concept, the interview method would help increase insight of a typical child's conceptual development of selected science concepts generally taught in the elementary schools in Indonesia.

Another study done by Klein (1982), in Children's Concept of the Earth and the Sun: A Cross Cultural Study was designed to assess the understanding of selected earth and solar system concepts of second graders. This study was designed to determine if there are differences in the kind of explanations given in the developmental pattern of the Mexican-American and Anglo-American children in the study. Ericson (1979), in Klein (1982), has emphasized that knowing what the learner "knows" is essential to both teachers and curriculum writers. One of the methods that can be used productively to determine what children know is the interview. In Klein's study, the interview consisted of a series of questions relating to the eight concepts: 1. We live on the earth, 2. the earth is round, 3. the earth is in space, 4. objects appear different from various perspectives, 5. the sun is larger than the earth, 6. night

and day are caused by the rotation of the earth, 7. sunrise occurs at different times at different geographical location because of the earth's rotation, 8. the earth makes one complete rotation every 24 hours.

In addition to Klein's study of student's concepts about earth, another study was done by Yuckenberg (1982) using first grade elementary students.

The study focused on children's conceptual understanding of certain concepts of astronomy. The questions were: 1. How big do you think the sun is? 2. How far away do you think the sun is? 3. What does the sun look like to you? 4. How hot do you think the sun is? 5. What would happen if the sun stopped shining? 6. What does the moon look like to you? 7. Tell me something you know about the moon. 8. They say they are going to send a man to the moon in a rocket. What would he have to take with him? 9) What is gravity?

The conclusions were 1. The astronomical concepts held by the children seem to show that their immediate knowledge had been extended to include many of the concepts held by adults. 2. This study seemed to show that if children already have some information about these concepts, it would seem wise to begin a study of astronomy at an early age.

This raises important questions regarding students' understanding of abstract objects in an early development. 3. These children showed a great deal of interest in the sun, the moon, and the earth.

The more recent study concerning Children's Explanation for Phenomena Related Manned Space Exploration- Gravity, Orbit, and Weightlessness: an Interview Study, was done by Nelson (1991). The subjects of the study were sixth grade students. The main questions of this study answered the following questions: 1. What are the explanations given by individual students to explain the causes and the effects of the phenomena of gravity, orbit, and weightlessness? 2. What explanatory categories concerning gravity, orbit, and weightlessness emerge from analysis of the students' responses? 3. How effective are these identified explanatory categories at capturing the intended meaning of the individual students? 4. What explanatory frameworks concerning gravity, orbit, and weightlessness can be generalized from identified explanatory categories?

CHAPTER III

METHODS AND PROCEDURES

Introduction

The purpose of the study was to elicit and analyze sixth grade students' explanations concerning the earth and related phenomena. This study examined Indonesian sixth graders' ability to identify cardinal directions on flat maps and globes; to explain and demonstrate what causes night and day on earth; and to identify the position of the earth, sun, and moon during lunar and solar eclipses. This study was held in the province of East Java, Indonesia, on the island of Madura, in the city of Bangkalan.

Background of the Researcher

Choosing Bangkalan as the location for the study was mostly related to the background of the researcher. Bangkalan is the hometown of the researcher where the researcher was an educator in a Teacher Training School for 15 years, from 1975 to 1990. This teacher training school was a high school that produced teachers for elementary

school. Many of the elementary school teachers in Bangkalan are former students of the researcher. The researcher was very familiar with elementary schools, the students, administrators, and the settings, since the researcher formerly served as a supervisor for student teaching in the elementary schools in Bangkalan. Also, many of the educational administrators are former students, friends, or relatives of the researcher.

Arrangements for Schools Visits

In order to get permission to conduct research involving many schools, specifically six-grade teachers and students in this district, the researcher first visited the Office of the Department of Education and Culture of Bangkalan on May 8,1996. The researcher introduced himself originally as an educator from Bangkalan and also as a graduate student at the University of Iowa, currently pursuing a Ph.D. degree in Science Education. The researcher asked requested the help of the educational authorities, principals and six-grade teachers in that order, asking for permission to collect data needed in the study. The researcher showed his advisor's letter explaining the proposed study to the authority of the Department of

Education in Bangkalan. The researcher asked the official to use ten schools that were located in five different areas in the city of Bangkalan. A list of ten schools and the interview schedule for each school were established by the Department of Education in Bangkalan on May 10, 1996.

The interview scheduled for each school called for 10 student interviews, each approximately 7 minutes in length, for a total of seventy minutes of student interviews. Also, 10-minute interviews for each of 4 teachers were scheduled at each of the respective schools.

The interviews were scheduled very tightly. This is possible to do in Bangkalan because the schools are within an area that is less than one mile in diameter. There are no traffic jams and one can travel quickly by motorcycle. So, the schedule only called for about 80 minutes for each school. The first student interviews were conducted in three days in a row on May 13, 14, and 15 (1996). On Monday, May 13, 1996, the first four schools were scheduled for interviews. School #1 scheduled 07:00-08:20, School #2 scheduled at 08:30-09:50, School #3 scheduled at 10:00-11:20, and school #4 11:30-12:50. On Tuesday, May 14, 1996, the next three schools were scheduled for interviews. School #5 scheduled 07:00-08:20, School #6 scheduled at 08:30-

09:50, and School #7 scheduled at 10:00-11:20. On Wednesday, May 15, 1996, the last three schools were scheduled for interview. School #8 scheduled 07:00-08:20, School #9 scheduled at 08:30-09:50, and School #10 scheduled at 10:00-11:20.

The second interviews were conducted on May 23, 24, and 25, 1996. On Thursday, May 23, 1996, the first four schools were scheduled for interview. School #1 scheduled 07:00-08:20, School #2 scheduled at 08:30-09:50, School #3 scheduled at 10:00-11:20, and school #4 11:30-12:50. On Friday, May 24, 1996 the next two schools were scheduled for interview. School #5 scheduled 07:00-08:20, School #6 scheduled at 08:30-09:50. School was closed at 11:00 on every Friday. On Saturday, May 25, 1996, the last four schools were scheduled for interviews. School #7 scheduled 07:00-08:20, School #8 scheduled at 08:30-09:50, School #9 scheduled at 10:00-11:20, and School #10 at 11:30-12:50.

For each of the scheduled interviews, the researcher first met with the principal. The researcher introduced himself to the principal and teachers, including the sixth grade teacher. After the introductions, the researcher explained the details of his study and requested help from the sixth grade teacher with the interview process. After

meeting with the total staff, the research interviewed the sixth grade teacher.

The same protocol was followed with the first four schools. However, in Schools 5-10, the research met with the principal and staff in a group, and then basically met with the sixth grade teacher to arrange for student interviews. With these teachers from Schools 5-10, the researcher did not interview in a formal sense to collect data, but merely arranged to meet the students and visited informally with them. The first four interviews had provided a relatively adequate sample of teacher responses from the different parts of the city.

Schools in the Study

Indonesian elementary schools are in session for approximately 10 months out of the year. They have different vacation times; some are related to religious holidays. The year is usually divided into trimesters. First and second grade usually have 32 sessions per week, each session being 30 minutes long. Grades 3-6 have 40 sessions per week, with 45 minutes per session.

Ten elementary schools were involved in this study, their codes, and their locations are explained briefly in

Table 1.

To represent the whole community in the city of Bangkalan, the schools selected in the study were taken from 5 different locations.

In general, an elementary public school in Bangkalan consists of six classes (grades 1-6). There is only one class for every grade level. The maximum number of students in each class is forty. For public schools in Indonesia, the general rule is that when the number of students in the area is more than the maximum load for each class, usually a new school would be built beside or close to that school. The schools are in session six days a week, Monday through Saturday, from 07:00 am to 01:00 pm. Sunday is the only day off for schools. Although Friday is not a holiday, all of the government or private business offices are closed from 11:00 am to 1:30 pm. to allow Moslem people to do Friday praying. In general, each elementary school in Bangkalan has one principal, six teachers, a PE teacher, a religion teacher and a janitor.

Most of the Indonesian elementary schools were designed for normal students. There are no special teachers to accommodate handicapped students in the public schools. In the whole city of Bangkalan there is only one private

special education school.

Teachers in the Study

The study was done in each of ten selected elementary schools in the City of Bangkalan. Four teachers were given a personal interview to gather their answers and explanations. Brief notes and an audio recording were written/recorded for each interview.

A sensitive battery operated tape recorder with ninety minutes cassettes was used to record the interviews. Although teachers were not the main concern in this study, their role, background, and teaching strategies were needed to clarify the students' responses. The four six-grade teachers were selected from schools from the higher socio-economic east side of the city and from the north side of the city that had representation from a more mixed socio-economic area (lower, middle, and upper level income families).

Most elementary teachers in Bangkalan were teach self-contained classes, meaning that they teach all subjects except Religion and PE.

Table 1

School's Code, Number of Students,

and Their Locations

School's Code	Number of Students	Its Location in the City
01	10	East
02	10	East
03	7	North
04	10	North
05	10	Central
06	9	Central
07	10	South
08	8	South
09	7	West
10	7	West

Before collecting the data, the researcher introduced himself to the teachers and explained what he needed in order to gather the information. The researcher explained that the results of the interview would be confidential and would be used to clarify students' answers given on other exams. The teachers were interviewed in the office room. The researcher asked the teacher to explain what teaching aids the teacher used in teaching the relevant parts of the curriculum.

The availability of teaching aids was also determined during the interview.

Unlike the student interviews, which concentrated on the content of the science material in detail, the teacher interviews (for Schools 1 - 4) focused on strategies they used to cover the material. The interview protocol for the teachers' interview was:

1. How do you teach night and day?
2. Do you use any teaching aids?
3. What kind of teaching aids does the school have?
4. What causes night and day?
5. How do the celestial bodies move?
6. Where does the sun rise, and set?

7. Where is the sun during the night?
8. How do you teach eclipse?
9. Do you have any students who are influenced by folklore in their explanations of eclipses?
10. Do you have any comment regarding science instruction or other related issues?

Sample of Opening Teacher's Interview

In Bahasa Indonesia

Contoh Pembukaan Interview Guru

(P: Peneliti; G: Guru)

P: " Kenalkan, nama saya Surachman"

G: " Ooo pak Surachman, Saya Etik Pak" (Bukan nama sebenarnya)

P: " Bagaimana kabarnya?"

G: " Baik-baik Pak. Kalau Bapak bagaimana?"

P: " Saya rindu sekali dengan Bangkalan"

G: " Oh ya bapak ada tugas akemana setelah lepas dari SPG?"

P: " saya bertugas ke UT Pusat Jakarta sampai pertengahan 1994. Selanjutnya saya sekolah ke amerika sampai sekarang ini"

G: " Aduh.. enak sekali ya.."

P: " Begini Bu, untuk keperluan penelitian saya mohon izin merekam pembicaraan kita ini. Hasil rekaman ini hanya untuk saya sebagai data penelitian dan bersifat rahasia"

G: " Oo..silakan Pak"

Sample of Content Teacher's Interview

In Bahasa Indonesia

Contoh isi Interview Guru

P: " Apa yang Ibu lakukan untuk mengajarkan topik terjadinya siang dan malam?"

G: " Maksudnya cara mengajarnya?"

P: " Ya termasuk persiapan mengajarnya"

G: " Untuk mengajarkan terjadinya siang dan malam saya menggunakan Globe dan senter. Di sini senter sebagai matahari nya. Lalu globe saya putar…".

P: " bagaimana penjelasannya?"

G: " saya jelaskan bahwa terjadinya siang dan malam karena terjadinya rotasi bumi pada porosnya"

P: " apa juga dijelaskan lama berputarnya?"

G: " Oh ya Pak, saya jelaskan bahwa karena bumi berotasi sekali dalam dua puluh empat jam, maka terjadi siang 12 jam dan malam 12 jam"

P: " bagaimana menjelaskan perputaran atau rotasi bumi?"

G: " bumi berotasi dari barat ke timur. Hal ini menyebabkan benda-benda langit seperti bulan, maatahari, dan bintang-bintang berputar dari timur ke barat"

Sample of Closing Teacher's Interview

In Bahasa Indonesia

Contoh Penutupan Interview Guru

P: "Bu Etik, saya sangat berterima kasih atas kesediaan ibu membantu saya dalam interview ini. Namun demikian saya masih minta tolong Bu etik untuk mengatur giliran anak-anak melaksanakan interview sekarang dan minggu depan.

G: " Ooo sama-sama Pak. Saya mau memanggil anak-anak sesuai dengan urutan nomernya satu persatu.

P: " Ya .. paling setiap anak memerlukan waktu sekitar sembilan menit"

G: " ya Pak saya siap membantu.

P: " Sekali lagi terima kasih lho atas bantuannya"

G: " Kembali Pak"

Sample of Opening Teacher's Interview

(R: Researcher; T: Teacher)

R: " Let me introduce myself, my name is Surachman."

T: " Oh Mr. Surachman, I am Etik" (fictitious name)

R:" How are you doing?"

T:" I am fine, how about yourself?"

R: " I am all right' thanks. Well for awhile I have been away from Bangkalan"

T: " Oh yes, where have you been since you left SPG Bangkalan?"

R: " Well I got promoted to a college teaching position in Jakarta until May 1994. Since then I have been in the US going to school. Any way, for the purpose of data collection I need your permission to record this interview. This recording will be confidential."

T: " I don't mind. Please go ahead"

Sample of Content Teacher's Interview

R: " Mrs.Etik, could you tell me how you teach night and day?"

T: "You mean how to teach it?"

R: "Yes."

T: "To teach the topic of night and day, I use a globe and flashlight."

R: "How do you explain what causes night and day?"

T: "Well, I taught that night and day is caused by the

earth's rotation on its axis."

R: "Do you tell students how long it takes to make one revolution?"

T: "Oh yes, I tell them that the earth rotates once in 24 hours. Therefore, the earth experiences 12 hours of day and 12 hours of night."

R: "What direction does the earth rotate?"

T: "The earth rotates to the east; therefore, the celestial bodies seem to move from east to west."

Sample of Closing Teacher's Interview

R: "Well, Mrs. Etik, I really appreciate your involvement in my study. However, I still need your help, especially to arrange ten of your students to interview."

T: "That is no problem, I will arrange the students as you request."

R: "The same students will be interviewed next week. Thanks again for your help."

T: "You are welcome, Mr. Surachman."

Post-Conference Data Collection

Teachers' records regarding their certificate, the year they graduated, and their teaching experience were

collected from the principals.

Students in the Study

The teachers, as requested by the researcher, randomly selected ten sixth grade students from their classroom. The researcher recommended a numbering system for randomly selecting the students. The names of the students in Bangkalan are arranged alphabetically. However female students are listed before male students. To illustrate, a class could have twenty female students and twenty male students, number 1 through number 20 would be female students. Then number 21 through number 40 would be male students.

To get a random group of ten students from each class, the researcher suggested that teachers start with a low number (1-5) and then select every third student. For example, the teacher could select Student 1,4,7,10… 2,5,8,11,... or 3,6,9,12,...etc.

Sixth grade students were chosen for this study for the following reasons. First, by this time in the sixth grade they have all been taught the topics of interest in the formal curriculum. Second, some of the material and concepts involved in this study were taught during the third

trimester, from February to May. Since this study was conducted in May, the material should still be fresh in the students' minds if they had followed the National Curriculum' timeline (the National Curriculum was adopted in 1994).

Each student was interviewed twice during a two-week period as planned. The second interview was a follow-up interview to complete and clarify what the student said in the first interview. Every student was asked the same numbers of questions, unless a student completely had no response at all.

Students were told that the researcher was formerly one of the teachers at Sekolah Pendidikan Guru (SPG), Teacher Training School in Bangkalan, from 1975 to 1990. The researcher then moved to Jakarta as a lecturer of Universitas Terbuka (Indonesian Open Learning University), and is currently a student at the University of Iowa pursuing his Ph.D. degree.

They were told that the purpose of the study was to collect data from them (six-grade students) about their understanding of Earth's movement and other related phenomena. This interview was just to be an interview, not a test. The results of the interviews will be secret or

confidential. The students were told not to worry about their responses.

The interviews made use of conducted in the office. Most elementary schools in Bangkalan have one big room the same size as a classroom that can be used for several needs, such as the principal's room, teachers' room, guest room, etc. The interview used guest furniture, consisting of one table and four chairs. Extra chairs or benches in the entry part of the office were needed for students to sit after they had been interviewed. After the interview the students were held in the office to prevent contact with those who were still going to be interviewed. This avoided sharing of information regarding interview materials.

The first interview was conducted without teaching aids, whereas during the second interview, the flat world map, globe, and eclipse model were used to see if differences in conceptual understanding could be attributed to the use of these materials. For the second interview, the researcher asked the teachers and the principals if they would gather the teaching aides (Solar System Model, Eclipse Model, globe, and flat world map).

Students were told that the interviews would be recorded. A sensitive battery operated audio tape recorder

was used. The recorder was placed on the table during the interview process. The record button was pushed at the beginning of the interview. To avoid disturbing students' concentration during the interview, the researcher only touched the pause button to start or stop the recording.

The researcher held a list of the topic questions for the interview. The list was written in English.

Only the content of the interview sessions was recorded, the welcoming conversations, introductions, and closing interviews were not.

The researcher made notes during the interviews. The note taking covered the student's name, date of birth, and responses to the interview questions. To document student actions, other than verbal actions, notes were made during the interview.

The student responses to the following interview questions were recorded.

1. a. What causes night and day?
   b. What do you mean by rotation?
   c. Where is the sun during the night?

2. a. How does the earth rotate?
   b. Can you show me with the globe?

c. How much time does it take for the earth to rotate once?

d. From this flat map, show me which direction is north, south, east, and west?

e. Which direction are you flying when you go from Japan to the U.S.A.?

f. Which direction are you sailing when you sail from Java to Borneo?

g. On this globe show me north, east, south, west.

h. Which direction are you traveling if you go from the North Pole to Indonesia?

3. a. What is an eclipse?

b. What kind of eclipses can we see from earth?

c. What causes a lunar eclipse?

d. Show me with this equipment (Eclipse Model), how a Lunar eclipse occurs.

e. With this equipment explain the movement of the moon and the earth with respect to the sun

f. What causes a solar eclipse?

g. Show me with this equipment (Eclipse Model),how a solar eclipse occurs.

Sample of Opening Student's Interview

In Bahasa Indonesia

Contoh Pembukaan Interview Murid

P: Peneliti, M: Murid.

P: "Selamat pagi."

M: "Selamat pagi Pak."

P: "Kenalkan nama saya Surachman, panggil saya pak Surachman. Oh ya siapa namamu?"

M: "Nama saya Anton Wiyono Pak." (Bukan nama sebenarnya)

P: "Pak Rachman sebenarnya orang Bangkalan. Saya dulu guru SPG Bangkalan sejak 1975 sampai 1990. Saya terus dinas di UT Jakarta sampai pertengahan 1994. Sekarang saya ada di Amerika untuk sekolah. Nah interview sekarang ini hanya untuk keperluan penelitian. Jadi hasilnya tidak ada hubungannya dengan nilai di sekolah. Interview ini akan direkam untuk pengumpulan data. Sekali lagi kamu tidak perlu khawatir bisa tidaknya menjawab pertanyaan-pertanyaan saya."

M: "Saya Pak"

Sample of Content Student's Interview

In Bahasa Indonesia

Contoh Isi Interview Murid

P: "Begini ya.. kamu tahu kan ada siang dan ada malam. Pertanyaan saya, apa yang menyebabkan terjadinya siang dan malam?"

M: "Terjadinya siang dan malam diakibatkan oleh bumi berotasi pada porosnya sekali dalam dua puluh empat jam."

P: "Nah kamu menyebutkan bahwa bumi berotasi, apa artinya berotasi?" Coba jelaskan, jika perlu ragakan dengan tubuhmu."

M: "Berotasi artinya berputar pada porosnya. Kalau misalnya saya sebagai bumi berotasi itu berputar, begini." (Murid memutar tubuhnya dengan memutar 360 derajad posisi kakinya).

P: "Pernah dengar istilah gerhana?"

M: "Pernah Pak."

P: "Tolong saya dijelaskan bagaimana terjadinya gerhana."

M: "Gerhana apa Pak?"

P: "Oh.. ada berapa gerhana yang kau ketahui, dan apa saja?"

M: "Ada dua pak. Gerhana bulan dan gerhanma matahari."

P: "Coba kamu tunjukkan kepada Pak Rachman posisi bulan,

bumi dan matahari dengan model gerhana ini."

M: (Murid mengatur posisi bulan, bumi dan matahari dengan alat peraga model gerhana.)

Sample of Closing Student's Interview

In Bahasa Indonesia

Contoh Penutupan Interview Murid

P: "Bagaimana tidak sukar kan?"

M: "Lumayan Pak."

P: "Pak Rachman terima kasih atas kesedianmu di interview."

M: "Kembali Pak"

P: "Saya mengucapkan terima kasih dan semoga kalian lulus dengan hasil yang baik."

M: "Terima kasih Pak."

P: "Semoga suskes dan selamat meneruskan ke SMP" (sambil memjabat tangan murid.)

Sample of Opening Student's Interview

R: "Good morning."

S: "Good morning, sir"

R: "Let me introduce myself, my name is Surachman. Call me Mr. Surachman. By the way, what is your name?"

S: "My name is Anton Wiyono (fictitious name). I heard that

you are from Bangkalan, is that right?"

R: "Yes, actually I was SPG teacher since 1975 to 1990, then I got a promotion to become a college teacher until May 1994. After that I went to the US to go to school. Any way this interview is for my research. Therefore the results of the interview will have no effect on your school grade. For the purpose of data collection the interview will be recorded. The recording will be confidential. Is it all right?"

S: "Yes sir."

Sample of Content Student's Interview

R: "Well, you know that there is night and day right? My question is: what causes night and day?"

S: "Night and day is caused by the earth rotating on its axis once in 24 hours"

R: "You told me that the earth rotates, what do you mean by rotate? Please explain and show me with your body."

S: "Rotates means revolves on its axis like this." (student shows with his body turning 360 degrees keeping his feet in the same place)

R: "How about eclipse, have you ever heard of an eclipse?"

S: "Yes, sir."

R: "Could you explain how an eclipse occurs?"

S: "What kind of eclipse, sir?"

R: "Well how many eclipses are there?"

S: "Two, lunar eclipse and solar eclipse."

Sample of Closing Student's Interview

R: "Well, what do you think of the interview? Easy, right?

S: "Not bad, sir."

R: "Thanks for taking the time to be involved in my study. I hope you will pass the examination and continue to junior high school"

S: "You are welcome, sir."

R: "Thanks again." (researcher shakes the student's hand)

S: "You bet, sir."

Sample of Follow-up Conference

After the interview processes, the researcher thanked the students for their help in the interview. The researcher also met with the principal and teachers and thanked them for their help.

Data Analysis

The data was analyzed as follows.

1. From interview notes and audio transcriptions, a table of student responses was created. Student responses would be categorized as correct or incorrect. The correct response would be scored as 1 point, the incorrect response would be scored 0 points. The judgment of correct and incorrect was based on the concepts as described in the national curriculum and the textbooks used.

   The researcher was careful to probe student responses if for some reason they seemed strange, e.g. if a student started giving correct responses, but then made a mistake. The question would be repeated to avoid that one small mistake negating the whole answer.

   Student information such as name, date of birth, grades in national exams, and their parents' income, was used to complement the interview data.

2. Transcribing was made from audio recordings of the teacher interviews. Teacher records, such as years of teaching experience were also collected as complementary information as was done with the student information.

CHAPTER IV

RESULTS AND DISCUSSION

Introduction

This chapter is divided into three sections. The first section discusses the schools involved in the study. The second section discusses the teacher interviews. The third section discusses the student interviews

The Schools

As explained in Chapter Three, the schools consisted of student classrooms, a principal's room, a teachers' work area, a small cafeteria, and restrooms. The principal's office and teachers' work area were in the same room. Teaching aids were placed in the classroom or in the teachers' work area. Although all of the teaching aids were government issue, the condition of the materials varied school-by-school. Most of the science materials were in fairly usable condition.

In general all ten schools in this study had

the same organizational and physical structure as that outlined in Chapter Two. The classrooms within the ten schools usually consisted of forty students. They sat in twos at 20 tables. A long blackboard was attached to he front wall of the class. Above the blackboard, an eagle woodcarving (Indonesian symbol) and the pictures of the Indonesian president and vice president hung side-by-side. The eagle symbolically has 17 wing feathers, 8 tail feathers, and 45 neck feathers. These numbers represent the date of Indonesian independence: August 17, 1945. The feet of the eagle hold the pledge of 'Bhineka Tunggal Ika' that stands for unity in diversity. A big Indonesian flag was placed at the front corner by the teacher's chair. A small blackboard hung in the front left corner to record the number of students, gender, and attendance. Pictures of local heroes and heroines, maps, and charts hung on the walls around the room. The main door was located in the front corner. Every classroom was connected with another classroom with a backdoor. The teachers' table and chair were located

in the front left corner of the class. A cabinet was located by the teachers' table. This cabinet was used to store the teachers' reference books, student homework or assignments, paper, rulers, chalk, and teaching aids. All of the classrooms were basically the same.

The principal's and teachers' work area and guest area were always in one room that was the same size as the other classrooms. Some cabinets were in this room in the different schools. These cabinets were used to store teaching aids, library books, and medals and trophies (music, sports, and marching). The arrangements of this room were basically the same in every school. In front of each school was a big yard. This yard was used as a playground, park, and for ceremonial announcements. A small cafeteria was also part of the main building. A parking lot for teachers' and principal's motorcycles, and student bikes was located adjacent to the school building.

Table 2 displays the number of students at each grade level in each school. School 6 was way below the average for every grade and consequently for the total school population as well. In Grade 1, there were only 24

students as compared to the average of over 36 in the other 9 schools. When School 5 grew too large, School 6 was built. In discussions with the principals of Schools 5 and 6, it was suggested that the comparative low enrollment in grade one in both schools could be explained by the role family planning was beginning to play in this attendance area.

Teacher Interviews

The purpose of the teacher interviews was to learn about the teachers' teaching methods, knowledge, barriers to instruction, and other issues that might arise. In general teacher interviews were conducted as planned. Four out of the ten teachers were interviewed. The interviews were conducted in the guest room of each respective school. These interviews took about ten minutes each. The teacher would sit across the table from the researcher. The researcher held notebook and pen and put a tape recorder on the table. The notebook contained the concepts for the third trimester for the sixth grade. The researcher asked for permission from the teacher to do the recording.

Table 2

The Number of Students in Ten schools

Gr.	Sch 1	Sch 2	Sch 3	Sch 4	Sch 5	Sch 6	Sch 7	Sch 8	Sch 9	Sch 10	Avg
1	42	41	39	40	28	24	40	36	36	37	36.30
2	44	40	26	35	40	33	35	32	37	28	35.00
3	41	46	39	38	41	36	41	38	44	33	39.70
4	44	40	39	31	39	31	34	24	44	35	36.10
5	38	41	37	37	38	28	38	33	42	30	36.20
6	36	40	38	40	35	32	28	31	44	34	35.80
Tot	245	248	218	221	221	184	216	194	247	197	219.1
Avr	40.83	41.33	36.33	36.83	36.83	30.67	36	32.33	41.17	32.83	36.52

Table 3

Schools' Demographics on Test Scores

for the Six Graders

School	Stu	Cert	Pop	Income	Sum	Sci	Tri
#1	10	SPG	36	252.50	38.32	7.52	7.70
#2	10	SPG	38	355.00	39.43	7.92	8.00
#3	7	SPG	38	407.14	37.18	6.63	6.68
#4	10	SPG	40	333.50	41.09	8.14	8.30
#5	10	SPG	35	407.50	37.79	6.91	7.30
#6	9	SPG	32	405.56	36.96	6.94	7.33
#7	10	DII	28	394.00	36.20	6.39	6.90
#8	8	SPG	31	225.00	38.10	7.26	7.63
#9	7	SPG	44	328.57	38.76	7.30	7.57
#10	7	SPG	34	371.43	34.21	6.56	7.00
Total	88		356	3480	378	71.57	74.41
Aver	8.80		35.80	348.00	37.8	7.16	7.44

Stu = Number of Students

Cert = teachers' certificate

- SPG = Sekolah Pendidikan Guru (Teacher Training School)

(Table 3 - Continued)

- D II= Diploma II certificate (A two Years Teaching College)

Pop = number of 6th grade students (population of class)

Income= Parents' monthly Income in thousands Rupiah

Sum = Sum of the National test score

Sci = National Science Test Score

Tri = Science score in third Trimester

Since three out of the four teachers interviewed were former students of the researcher, they were pleased to have a chance to talk to their former teacher. Nevertheless, the researcher tried to keep the discussion as focused on the research as possible. All 4 teachers indicated that their teaching loads were very heavy. They said this was caused by the fact that the official curriculum they had to cover was so much. They had to review the material from prior years along with the content assigned to their grade because the government exams covered the material from grades 3, 4, 5, and 6. The final exams consisted of five subject matters, namely civics, Bahasa Indonesia, math, science, and social studies. In science for example, the third trimester for six graders covered astronomical concepts, however teachers indicated they had to review all of the biological and other physical science materials from grades 3 - 5.

In terms of the teaching method, most of the teachers

reported that they used the lecture method exclusively. Three out of four teachers said they used the teaching aids available in their school. These included the solar system model, the eclipse model, and the globe. One teacher told that she had problems using the teaching aids. She reported that she needed training to use the equipment. Some of the equipment to teach the units on astronomy were not in working order.

As noted earlier, three of the four teachers interviewed were prior students of the researcher. As such, they expected and asked for answers on how to improve their teaching. They were frustrated with their students' performance, and they sincerely wanted to be told how to teach better. As their prior teacher, they looked to the researcher for answers. Culturally, it was difficult to be just a researcher and an observer in these cases. At times, the researcher had to provide more direct suggestions and teaching strategies than would normally be expected in a research interview of the type conducted. The wisdom of the suggestions provided could be debated, but that was not the goal of this study. In the brief time available, the researcher tried to answer as quickly as possible, knowing that there was not sufficient time to do the training and provide the suggestions that were needed and still conduct

the interview.

When probing the teachers' knowledge to see if they had any misconceptions, only one surfaced. One teacher explained that the sun was in the west during the night. The researcher was non-judgmental at this point. This was the only really evident misconception that surfaced in these interviews. In almost all the other cases, the teachers answered quickly and correctly the knowledge questions.

The teachers also wanted to talk about their frustrations. Sometimes they wanted to tell their story. They wanted to tell how difficult their job was, especially how difficult it was to cover the content in the curriculum and prepare the students for the government tests.

Some of the teachers expressed their frustration with how their students performed on the exams. They had drilled the students on the material, but the students had not performed as well as desired on the exams administered by the local educational examiner. The students had not yet taken the official state exam; it was to be conducted in one week after the teacher interviews. This frustration was common among all four teachers interviewed.

In summary, the teacher interviews made it clear to the researcher that the teachers were frustrated because they had so much curriculum to cover; they were frustrated

because their students did not perform as well as they wanted; they were frustrated because they knew they needed more training on ways to use the equipment and to teach the concepts more effectively. In general the content knowledge of the teachers was good.

Student Interviews

In general student interviews were conducted as described in Chapter III. The interviews took about seven minutes per student. The interview process was conducted in the guest area in the office. An extra bench and chairs from the office were used to seat the students after they were interviewed. The researcher sat in the guest chair. Students came after they were called for their turn. The sixth grade teacher helped to arrange and call the students. Each student was interviewed twice. The researcher told the sixth grade teachers to explain to their students that the purpose of the interview was for data collection. They were to emphasize that the interview would not affect the student's grade or general performance. However the researcher still emphasized this to the students at the start of each interview.

To reduce student tension, the researcher welcomed each student in the local dialect. The researcher explained to

each student that he was from Bangkalan just like they were.

The pause button on the tape recorder was pushed after a brief explanation was given to the students. The researcher just needed to push the pause button in order to start or stop recording. 120 minute audiocassettes were used to provide plenty of time and eliminate any need to change the cassette. The researcher held his notebook and pen and took notes during the interview.

Fewer students participated in the second interview. These differences are displayed in Table 4.

The first interview was conducted before the final exam and the second interview was conducted after the final exam.

During the interviews, some students had trouble responding to the questions; therefore, the researcher needed to rephrase the question at times. Or, sometimes the pace of the questions had to be adjusted by the researcher when facing students who appeared very nervous. In these cases, the researcher explained to the students again that the interview was just part of a study and the student's answers would not affect their grade in any way.

The student's responses during the two interviews were scored. The interview material covered four main questions: What causes night and day? What direction does the earth rotate? How do eclipses occur? And,

Table 4

Subjects in the Study

School Code	# 1st Interview	# 2nd Interview
1	10	10
2	10	10
3	10	7
4	10	10
5	10	10
6	10	9
7	10	10
8	10	8
9	10	7
10	10	7
Total	100	88

could they tell what direction it was from (Point A) to (Point B) on a flat world map and on a globe?

The first interview was a dialogue. Students answered questions verbally without any models. In the second interview students were given a flat world map, globe, and eclipse model as described in Chapter III. Using the globe students were asked to show how the earth rotates. Using the eclipse model students were asked to show the position of the earth, moon, and sun when an eclipse occurred. And, using a flat map and globe students were asked to show the four main directions. Data from students who did not participate in the second interview were excluded from further analysis. Eighty-eight subjects out of 100 participated in both interviews.

In scoring student responses to the four main directions, one point was given if the student could identify all four directions; 0.75 point was given for three directions correct; 0.50 point for two directions correct; 0.25 point for only one direction correct, and 0 points for no correct response for the four main directions.

Recording Student Performance and Coding Their Responses

One point was awarded for each correct answer during the interview. Incorrect answers or unacceptable responses were given 0 points (except for identifying the cardinal directions where partial credit was awarded if 1-3 cardinal directions were correctly identified).

Sample Scoring During Interview

R: "What causes night and day?"

S: "Because the earth rotates on its axis." Given 1 point.

S: "Because the sun goes around the earth." Given 0 points.

R: "Supposed you are the earth or globe, show me with your body, how the earth rotates."

S: Given 1 point if they turned to the left (counter-clockwise).

S: Given 0 points if the student did not respond at all.

R: "The earth rotates on its axis. Show me how the earth rotates with this globe."

S: Given 1 point if the student rotated the globe to the east or counter-clockwise (looking down from the top of the globe).

S: Given o points if the student did not respond at all or

rotated the globe to the west or clockwise (looking down at the top of the globe).

R: "Explain the position of the sun, the earth and the moon during a lunar or solar eclipse. You can choose either one."

S: Given 1 point if the student replied as follows: " A lunar eclipse occurs when the sun, the earth, and the moon are in one line. The earth blocks the sun's light to the moon. Or, a solar eclipse occurs when the sun, the moon, and the earth are in a line. The moon blocks the sun's light to the earth."

S: Given 0 points when the student did not respond at all or gave an incorrect response.

R: "What direction do you fly if you are traveling from the Philippines to Indonesia?" (The two locations were identified by the researcher on the globe or flat plan)

S: Given 1 point if the student responded to the south.

S: Given 0 points if the student did not respond at all, or gave an incorrect direction.

R: "Show me with this globe, what direction it is if you sail from Borneo to Celebes?" (the two locations were identified by the researcher on the globe or flat map)

S: Given 1 point if the student replied to the east.

S: Given 0 points if the student replied other than to the

east.

Student Performance

The students' responses are summarized according to the four tasks they were asked to perform: "What causes night and day?" "How does the earth rotate?" "What causes an eclipse?" and "Identify the direction you would be traveling if you go from (Point A) to (Point B)."

What Causes Night and Day?

Students were interviewed without visual aids in the first interview. Table 5 shows the student performance on the first question. This question was asked in the first interview only.

As shown in Table 5, on Question 1, the students generally could describe what caused night and day. Eighty out of 88 students (about 91%) answered correctly. Or, only 8 out of 88 students (about 9%) students could not describe it.

In schools 1, 3, 9, and 10, all the students interviewed successfully described what caused night and day. In terms of those who were correct, there didn't seem to be a difference in terms of the age of the students interviewed or in terms of their gender, they all seemed to

do about the same.

Which Direction does the Earth Rotate?

Students were asked to stand and then asked to physically turn to show the direction the earth rotates. Students were told to pretend that they were a globe and to turn the same way the earth would rotate to create night and day. Sometimes the students were confused by these directions. In these cases the question was usually rephrased and it was stressed that the student should show "how" the earth rotates to create night and day.

In the second interview, the students were reminded of the first interview and the discussion about what causes night and day. They were reminded that night and day are caused by the earth's rotation. They were then given a globe and flashlight and they were told that the flashlight was the sun and the globe was the earth. They were then asked to show how the earth rotates to cause night and day.

Table 6 displays the coded results of the students' performance during the first and second interviews. In the first interview they were using their body to show which way the earth rotates. In the second interview they were using a flashlight and spinning the globe to show the direction it rotated.

Table 5

Scores Given in the two Interviews

	Questions	1st Interview	2nd Interview
1	What causes night and day	1	N/A
2	Showing how the earth rotates	1	1
3	How the eclipse occurred	1	1
4	Identify four cardinal directions	N.A.	1

Table 6

Question 1. What Causes Night and Day?

SCHOOLS	STUDENTS									
	1	2	3	4	5	6	7	8	9	10
1	1	1	1	1	1	1	1	1	1	1
2	1	1	1	1	0	0	1	1	1	1
3	1	1	1	1	1	1	1			
4	1	1	1	1	1	1	1	1	0	1
5	1	1	1	1	1	0	1	1	1	1
6	1	1	1	1	1	1	0	1	1	
7	0	1	1	1	0	1	1	1	1	1
8	1	1	1	1	1	1	0	1		
9	1	1	1	1	1	1	1			
10	1	1	1	1	1	1	1			

Note

Red color: Student incorrectly answered the question.

Six out of 88 students (about 7%) could not describe correctly how the earth rotates both in the first and second interview. And 44 out of 88 students (50%) could correctly describe the direction the earth rotates in both interviews.

One of the more interesting findings is that students had more problems when given the flashlight and globe than they when simply asked to stand and show which way the earth rotates to cause night and day.

Twenty-seven out of 88 (about 33%) could show with their body how the earth rotates to cause night and day, but could not show when given the globe and flashlight. However only 10 out of 88 (about 11%) could not accomplish the first task but could show when they were given the flashlight and globe. A caution has to be raised with this finding. When asked to show with their body, the students had a 50/50 chance of being correct, so one cannot put too much importance or confidence on this data. It appeared that some students were just lucky. In these cases, the researcher noticed that when the students were given the globe, some students seemed very confused. The researcher would explain to the students that the globe is like a small earth in an attempt to try to relax the student. But, the students still had mixed results. It seemed to the researcher that these students were not very clear about or

familiar with the globe. Perhaps the teachers had not used the globe in their class demonstrations, or had used it in a way that was not clear to these students. The students seemed to have more trouble with the globe than when showing the rotation with their body.

In the second interview, even though some students seemed confused by the globe, the researcher did notice that the students seemed to be thinking much more than in the first interview. They seemed to use the flashlight and globe, when they were comfortable with the globe, to figure out which way the globe would turn.

The differences between schools were not very noteworthy. Students from Schools 1 and 9, got all the answers right on the first interview, but the numbers are not that different from one school to the next. The patterns between Interview 1 and Interview 2 are more interesting than the differences between schools.

What Causes an Eclipse?

To answer this question, students had to explain the proper position of the sun, earth, and moon during an eclipse of the moon (lunar eclipse) or during an eclipse of the sun (solar eclipse).

Tsble 7

Question 2. Which way does the earth rotate?

SCHOOLS	STUDENTS																			
	1		2		3		4		5		6		7		8		9		10	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2d	1st	2nd	1st	2nd	1st	2nd
1	1	0	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	0	1	0
2	1	1	1	1	1	0	0	1	1	1	0	1	0	0	1	1	1	1	1	1
3	1	1	1	0	1	1	0	0	1	1	1	0	1	0						
4	1	1	1	0	1	1	0	0	1	0	1	1	1	1	1	0	0	1	1	0
5	1	1	1	0	1	1	1	0	0	0	0	1	1	0	0	1	1	0	1	1
6	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1		
7	0	1	0	0	1	1	0	0	0	1	1	0	1	1	1	0	1	0	1	1
8	1	1	1	1	1	1	1	1	1	0	1	1	0	1	1	0				
9	1	1	1	1	1	1	1	0	1	1	1	0	1	1						
10	0	1	1	1	1	0	1	0	0	1	1	1	1	1						

Note:

Color	Meaning
White	Student able to answer both first and second interview
Red	Student able to answer first interview but not the second one
Green	Student unable to answer the first interview but able to answer the second one
Yellow	Student unable to answer both first and second interviews

Students were interviewed verbally in the first interview, whereas the model of the eclipse was provided in the second interview.

Seven out of 88 students (about 8%) were not able to explain in either the first or the second interview. And 56 out of 88 (about 64%) were successfully able to explain in both interviews. Twenty out of 88 (about 23%) could not explain without the model, but could explain when the model was present. This is important information. It evidently shows how students can think if they have a physical model. Only 4 out of 88 (about 5%) could explain but not demonstrate. However, this raises questions, because it means that they truly may not understand what they are saying.

School #1 continued to do very well on the concepts. Only two students had difficulty. However, overall the school effect was mixed again. There did not seem to be any clear school effects other than the fact that students from School 1 consistently did well in the interviews.

Identify Four Cardinal Directions

Eighteen out of 88 students (about 20%)were not able to identify the four cardinal directions. Four out of 88 (about

Table 8

Question 3. Eclipses

	STUDENTS																			
	1		2		3		4		5		6		7		8		9		10	
SCHOOL	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1
2	1	1	1	1	1	1	0	1	0	1	1	1	1	0	1	1	1	1	0	0
3	0	1	1	1	0	1	1	1	1	1	1	1	1	1						
4	1	1	0	1	1	1	1	1	1	0	1	1	0	0	0	0	1	1	1	1
5	0	1	0	1	0	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1
6	1	1	1	1	0	1	0	0	0	1	1	1	1	1	0	1	1	1		
7	1	1	0	1	0	1	0	1	1	1	1	1	1	1	0	1	1	1	1	1
8	1	1	1	1	1	1	1	1	0	1	0	1	1	1	1	1				
9	1	1	1	1	1	1	0	1	1	1	0	0	1	0						
10	1	1	0	1	1	1	0	0	1	1	1	1	1	1						

Note: Color Meaning

White	Student able to answer both first and second interview
Red	Student able to answer first interview but not the second one
Green	Student unable to answer the first interview but able to answer the second one
Yellow	Student unable to answer both first and second interviews

Table 9

Question 4. Identify Four Cardinal Directions

SCHOOLS	STUDENTS									
	1	2	3	4	5	6	7	8	9	10
1	1	0	1	[illegible]	0	1	0	0.5	0.5	0.5
2	0	1	0	[illegible]	1	0	1	1	0	0.5
3	0.5	0.5	0.5	[illegible]	1	0	0			
4	1	0	1	[illegible]	1	1	0	0	1	1
5	1	0	1	0.5	0.5	1	0.5	0.5	[illegible]	0.5
6	1	1	1	1	1	0.5	0.5	1	0.5	
7	1	1	1	0.5	1	1	1	1	1	0
8	1	[illegible]	1	[illegible]	1	1	0.5	1		
9	1	1	1	1	0.5	0.5	0.5			
10	0.5	0	0	0	0.5	0.5	0.5			

Note: Color Meaning

White	Student able to explain four cardinal directions
Green	Student able to explain two cardinal directions
Blue	Student only able to explain one cardinal direction
Red	Student unable to explain cardinal directions at all

5%)students were only able to show one cardinal direction. Twenty-five out of 88 students (about 28%) could show 2 cardinal directions. None of the students identified just three cardinal directions. And 41 out of 88 students (about 47%) identified all four cardinal directions.

Student Misconceptions

From the notes and interview recordings, several student misconceptions were revealed.

During Night the Sun was Located in the West

When the interviewer asked about night and day, students were asked about the position of the sun. For example:

(R: Researcher; S: Student)

R: "What causes night and day?"

S: "The earth' rotation."

R: "How does the earth rotate?"

S: "It rotates from west to east; therefore the sun and stars look like they move from east to west."

R: "So, where is the sun during the night?"

S1: "The sun is on the other side of the earth, we can not see the sun during the night." (The right answer)

S2: "During night the sun is in the west, because the sun

sets in the west, it must be in the west." (Misconception)

In those cases where this misconception occurred, the students were from the teacher's class where the teacher had responded with the same misconception. Therefore the teacher's misconception more than likely influenced the students' perceptions.

Facing Mecca is Always Westward

In Bangkalan, where the study was conducted, the population of the city was overwhelmingly Moslems. As Moslems pray at least five times a day, they face the Caaba in the city of Mecca, in Saudi Arabia. The Caaba is made up of cube shaped stones as the unity for all of the Moslems in the world facing to where they are praying. From Indonesia, Bangkalan City especially, Moslems would be facing westward when they pray. Therefore, there were possible influences from this habit of facing westward to Mecca.

When interviews were conducted using the flat world map, the questioning strategy was altered at times depending on the students' disposition; however, the focus of the questions remained the same. In one case, two students were asked to pick an area besides Indonesia and to select two important cities. They chose the Middle East as the location. The two

cities were Mecca and Medina in Saudi Arabia. The researcher asked the students. "From Medina to Mecca what direction would you be facing?"

The Students responded "westward." The right answer should be "southward". It might be that these students did not realize the real location, and automatically they thought about the fact that in Indonesia when they face Mecca they are always facing westward.

One Student had Problems Showing North With Two- and Three-Dimensional Shapes

One student was unable to show north. He pointed upward for north. It was possible that this student remembered how the teacher explained the four main directions on a flat map hanging on the wall. In this case, north was identified as being up on the map. This particular student had difficulty when in the interview the map was placed on the table; it was not hanging on the wall. This same student also identified north as being away from the center of the globe. North was seen as being perpendicular to the surface of the globe.

Confusion in Moving from a Flat Map to a Globe

A further question was conducted to answer more

information when the researcher noticed a strange response. One student was confused when faced with a flat map and asked to identify cardinal directions first with a flat map and then with a globe. It might be that the student was confused with the fact that the globe was tilted. In this case, when the student was asked to show east on the globe, the student pointed to the northeast instead of to the east. The direction the student pointed was the same direction as with the flat map. This was not correct because the globe was tilted, unlike in the flat map. When the student was asked to show west direction on the globe, the student pointed southwest instead of west. The researcher conducted a further probe for north and south. When the researcher asked the student to show north on the globe, the student pointed north-northwest instead. This is very important information with the fact that the globe is tilted 23.5 degrees from a vertical line.

CHAPTER V

CONCLUSION

This chapter consists of four sections. The first section presents the findings of this study. The second section explains the limitations of the study. The third section promotes some suggestions and recommendations for further studies. And the fourth section summarizes the most important contribution of this study.

The Findings

The followings are the most important findings in this study:

1. Most students demonstrated an understanding of what causes night and day. This question can be categorized as a recall question. Also the teachers seemed to be effective in teaching this concept.

2. Only approximately 50% of the students could demonstrate the direction of the earth's rotation that causes night and day. This poor showing resulted even though the students had just completed a unit of study

where this concept was a central or key component of the unit. Because students have the daily experience of watching the sun cross the sky, it seems they easily begin to think that night and day are caused by the sun moving, not from the earth's rotation. It would appear that the purely lecture mode used by many teachers is not effective in developing this student understanding. It could be that teachers should provide more concrete learning experiences to help students understand the different perspective. It also could be that this concept is placed too early in the official curriculum. It would be wise to investigate whether students can really take this different perspective given different instruction, since this concept is counter-intuitive given the students' daily observations. It could be that students at the sixth grade level cannot understand this concept no matter how it is presented because it runs contrary to their personal daily observations. More studies should be made of this to provide more clarity for future decisions.

3. About 64% of the sixth grade informants could explain what caused an eclipses (lunar or solar). It appeared

to the researcher that the eclipse model helped students to think through the phenomena of an eclipse and helped them correctly identify the positions of the sun, the earth, and the moon during an eclipse. Given the fact that many of these students could not identify the direction of the earth's rotation that causes night and day, the presence of the model seemed to have an instructional benefit that the students could successfully demonstrate an understanding of the positions of these celestial bodies during an eclipse. Evidently, sixth grade students are able to understand this abstract concept. This suggests that they should also be able to understand that the earth's rotation causes night and day. As noted earlier, this should be investigated.

4. Cultural differences affect student thinking. If teachers are sensitive to the fact that cultural understandings can influence what students think, they can be more effective in avoiding student misconceptions and help students understand their world in a more complex way. If they are not aware of these cultural influences, then it is too easy for a student to develop a misconception. This was

demonstrated in the study when students appeared to hold the misconception that Mecca has to be west of everywhere, since it is west of their home in Indonesia. This was another example of where a student misconception needs to be identified and corrected. Otherwise, as research as shown in the past, the student's misconception is resistant to change.

5. The way teachers teach seemed to influence student thinking. It is easy for students to think that up is north. Most maps in classrooms are hung from a wall or pinned to a wall. Teachers have to help students realize that going north is not the same as going uphill. Teachers should also realize the importance of using many examples where students transfer from a globe to a flat map and to the actual physical area. The uneasiness that some students had with globes seems to show that students need multiple experiences using the objects if they are going to be able to use them as educational tools or tools for understanding.

6. The position of the globe in relation to its base also appeared to cause confusion. It would appear that

teachers should explain why the globe is not positioned in a position perpendicular to its base but is tilted at an angle. A student was confused as to what direction north is when he saw that the globe tilted. Again, the persistence of the misconception that north is up. Teachers evidently should take steps to clarify that this is not the case.

Limitations of the study

The study was done in the small city of Bangkalan, with a small sample of about 100 students. Findings should not be generalized to all sixth grade students in Indonesia which number about 3.3 million students (Badan Penelitian dan Pengembangan Pendidikan dan Kebudayan, Pusat Informatika, 1992). However, the findings do suggest that the possibility exists that the same type of confusion and lack of understanding is possible throughout Indonesia. This study was an exploratory study. It was not designed to test an hypothesis or to generalize to the total Indonesian sixth grade population.

One could expect similar findings in other areas of Indonesia since all Indonesian public schools have very limited funds and since the school facilities only differ slightly from school to school. It is possible that

parental and other community and cultural differences might change the results of this study.

Important Research Needs to be Conducted

In this study, six graders had difficulty explaining 'how the earth rotates'. If this is the case, to insure this finding, it is recommended to do the research to probe more information detailing how sixth graders comprehend this concept. Other follow-up studies of how the earth moves around the sun, and how the moon revolves around the earth at the same time it revolves around the sun are also recommended.

This study should be replicated, changing the protocols or questions used in the interview. Students should be asked to: 1) show how the earth rotates to create night and day by using the globe. 2) Explain how the earth moves surround the sun. 3) Demonstrate how the earth rotates while it moves surround the sun. 4) Explain how the moon move in connection with the earth and the sun. Teaching aids should be used in the interview process. The teaching aids needed should be a globe, flashlight, and eclipse model. The interview time should be extended for each student from 7 minutes to 10 minutes. The researcher should select the students from the class to guarantee that a

random sample is selected. Also it might be better if the researcher borrowed one set of the teaching aids from one of the schools in the study rather than using different equipment at each school.

Summary

In terms of the elementary science curriculum, students clearly demonstrated that the recall question (What causes night and day?) was less difficult compared do the comprehensive question (How does the earth rotate?). The role of teaching aids, especially good teaching aids such as the eclipse model, clearly appeared to help students think and explain the abstract concept of the positioning of the celestial bodies during an eclipse.

Student misconceptions were not only influenced by previous experience, such as everyday life (seeing the sun rise in the east and set in the west); but by cultural background (facing Mecca always westward) and teaching methods (the use of a flat map on the wall or on a table; and the use of a globe).

Probably the most important conclusion of this study is the need for more research to probe and analyze the depth of understanding students have after studying abstract concepts

such as the rotation of the earth (causing night and day) and the tilting of the earth axis in relation to the earth's orbit around the sun as currently presented in the national Indonesian curriculum. It is quite possible that the intended curriculum and the experienced curriculum are quite different and that educators, both teachers and curriculum planners, have unrealistic expectations about what could or should be learned about the solar system in the elementary grades.

APPENDIX

STUDENTS' PERFORMANCE

DURING TWO INTERVIEWS AT TEN SCHOOLS

Table 10

Students' Performance During Two Interviews at School No.1

				First Interview			Second Interview		
No	Code	Gen	Ages	1.1	1.2	1.3	2.1	2.2	2.3
1	101	F	11.92	1	1	1	1	0	1
2	102	F	12.08	1	1	1	0	1	1
3	103	F	12.67	1	1	1	1	1	1
4	104	M	12.83	1	1	1	.25	0	1
5	105	F	14.00	1	1	1	0	1	1
6	106	M	15.25	1	1	1	1	1	1
7	107	M	12.17	1	1	1	0	1	1
8	108	F	11.67	1	1	1	.5	1	1
9	109	M	12.17	1	1	1	.5	0	0
10	110	M	13.50	1	1	0	.5	0	1
	Total			10	10	9	4.75	6	9

Note

Code	Question
1.1	What causes night and day (explain verbally)
1.2	Showing how the earth rotates (with the body)
1.3	How the eclipse occurred (explain verbally)
2.1	Identify four cardinal directions (with the flat map and the globe)
2.2	Showing how the earth rotates (with the globe)
2.3	How the eclipse occurred (showing with the eclipse model)

Table 11

Students' Performance During Two Interviews at School No.2

				First Interview			Second Interview		
No	Code	Gender	Ages	1.1	1.2	1.3	2.1	2.2	2.3
1	201	F	11.67	1	1	1	0	1	1
2	202	F	11.58	1	1	1	1	1	1
3	203	F	12.33	1	1	1	0	0	1
4	204	F	11.92	1	0	0	0	1	1
5	205	F	12.25	0	1	0	1	1	1
6	206	M	12.83	0	0	1	1	1	1
7	207	F	12.75	1	0	1	1	0	0
8	208	M	12.83	1	1	1	1	1	1
9	209	F	12.17	1	1	1	0	1	1
10	210	M	12.83	1	1	0	.5	1	0
	Total			8	7	7	5.5	8	8

Note

Code	Question
1.1	What causes night and day (explain verbally)
1.2	Showing how the earth rotates (with the body)
1.3	How the eclipse occurred (explain verbally)
2.1	Identify four cardinal directions (with the flat map and the globe)
2.2	Showing how the earth rotates (with the globe)
2.3	How the eclipse occurred (showing with the eclipse model)

Table 12

Students' Performance During Two Interviews
at School No.3

				First Interview			Second Interview		
No	Code	Gender	Ages	1.1	1.2	1.3	2.1	2.2	2.3
1	301	F	12.75	1	1	0	.5	1	1
2	302	F	12.17	1	1	1	.5	0	1
3	303	F	11.92	1	1	0	.5	1	1
4	304	F	12.58	1	0	1	.5	0	1
5	305	F	13.25	1	1	1	1	1	1
6	306	M	12.50	1	1	1	0	0	1
7	307	F	12.83	1	1	1	0	0	1
	Total			7	6	5	3	3	7

Note

Code	Question
1.1	What causes night and day (explain verbally)
1.2	Showing how the earth rotates (with the body)
1.3	How the eclipse occurred (explain verbally)
2.1	Identify four cardinal directions (with the flat map and the globe)
2.2	Showing how the earth rotates (with the globe)
2.3	How the eclipse occurred (showing with the eclipse model)

Table 13

Students' Performance During Two Interviews at School No.4

				First Interview			Second Interview		
No	Code	Gender	Ages	1.1	1.2	1.3	2.1	2.2	2.3
1	401	F	12.33	1	1	1	1	1	1
2	402	F	11.50	1	1	0	0	0	1
3	403	M	12.58	1	1	1	1	1	1
4	404	F	12.42	1	0	1	.5	0	1
5	405	F	12.08	1	1	1	1	0	0
6	406	M	12.00	1	1	1	1	1	1
7	407	M	12.17	1	1	0	0	1	0
8	408	F	11.75	1	1	0	0	0	0
9	409	M	11.92	0	0	1	1	1	1
10	410	F	11.25	1	1	1	1	0	1
	Total			9	8	7	6.5	5	7

Note

Code	Question
1.1	What causes night and day (explain verbally)
1.2	Showing how the earth rotates (with the body)
1.3	How the eclipse occurred (explain verbally)
2.1	Identify four cardinal directions (with the flat map and the globe)
2.2	Showing how the earth rotates (with the globe)
2.3	How the eclipse occurred (showing with the eclipse model)

Table 14

Students' Performance During Two Interviews
at School No.5

				First Interview			Second Interview		
No	Code	Gender	Ages	1.1	1.2	1.3	2.1	2.2	2.3
1	501	M	12.33	1	1	0	1	1	1
2	502	F	11.50	1	1	0	0	0	1
3	503	F	11.92	1	1	0	1	1	1
4	504	F	12.00	1	1	1	.5	0	1
5	505	F	12.67	1	0	1	.5	0	1
6	506	F	12.17	0	0	1	1	1	1
7	507	F	12.00	1	1	1	.5	0	1
8	508	F	11.83	1	0	1	.5	1	1
9	509	F	11.50	1	1	0	.25	0	0
10	510	F	12.83	1	1	1	.5	1	1
	Total			9	7	6	5.75	5	9

Note

Code	Question
1.1	What causes night and day (explain verbally)
1.2	Showing how the earth rotates (with the body)
1.3	How the eclipse occurred (explain verbally)
2.1	Identify four cardinal directions (with the flat map and the globe)
2.2	Showing how the earth rotates (with the globe)
2.3	How the eclipse occurred (showing with the eclipse model)

Table 15

Students' Performance During Two Interviews
at School No.6

				First Interview			Second Interview		
No	Code	Gender	Ages	1.1	1.2	1.3	2.1	2.2	2.3
1	601	F	12.83	1	1	1	1	1	1
2	602	F	12.33	1	0	1	1	0	1
3	603	M	12.50	1	1	0	1	1	1
4	604	F	12.50	1	1	0	1	1	0
5	605	F	11.33	1	1	0	1	1	1
6	606	F	11.50	1	1	1	.5	1	1
7	607	F	12.50	0	1	1	.5	1	1
8	608	F	12.08	1	1	0	1	1	1
9	609	F	12.33	1	1	1	.5	1	1
	Total			8	8	5	7.5	8	8

Note

Code	Question
1.1	What causes night and day (explain verbally)
1.2	Showing how the earth rotates (with the body)
1.3	How the eclipse occurred (explain verbally)
2.1	Identify four cardinal directions (with the flat map and the globe)
2.2	Showing how the earth rotates (with the globe)
2.3	How the eclipse occurred (showing with the eclipse model)

Table 16

Students' Performance During Two Interviews at School No.7

				First Interview			Second Interview		
No	Code	Gender	Ages	1.1	1.2	1.3	2.1	2.2	2.3
1	701	F	12.08	0	0	1	1	1	1
2	701	M	12.17	1	1	0	1	0	1
3	703	F	12.25	1	1	0	1	1	1
4	704	M	12.92	1	0	0	.5	0	1
5	705	M	14.25	0	0	1	1	1	1
6	706	M	12.75	1	1	1	1	0	1
7	707	M	11.25	1	1	1	1	1	1
8	708	M	12.25	1	1	0	1	0	1
9	709	M	12.00	1	1	1	1	0	1
10	710	M	12.25	1	1	1	0	1	1
	Total			8	7	6	8.5	5	10

Note

Code	Question
1.1	What causes night and day (explain verbally)
1.2	Showing how the earth rotates (with the body)
1.3	How the eclipse occurred (explain verbally)
2.1	Identify four cardinal directions (with the flat map and the globe)
2.2	Showing how the earth rotates (with the globe)
2.3	How the eclipse occurred (showing with the eclipse model)

Table 17

Students' Performance During Two Interviews
at School No.8

				First Interview			Second Interview		
No	Code	Gender	Ages	1.1	1.2	1.3	2.1	2.2	2.3
1	801	M	12.33	1	1	1	1	0	1
2	802	F	11.92	1	1	2	.25	1	1
3	803	M	12.17	1	1	1	1	1	1
4	804	M	12.08	1	1	1	.25	1	1
5	805	F	12.00	1	1	0	1	0	1
6	806	F	12.25	1	1	0	1	1	1
7	807	F	12.50	0	0	1	.5	1	1
8	808	F	13.00	1	1	1	1	0	1
	Total			7	7	7	6	5	8

Note

Code	Question
1.1	What causes night and day (explain verbally)
1.2	Showing how the earth rotates (with the body)
1.3	How the eclipse occurred (explain verbally)
2.1	Identify four cardinal directions (with the flat map and the globe)
2.2	Showing how the earth rotates (with the globe)
2.3	How the eclipse occurred (showing with the eclipse model)

Table 18

Students' Performance During Two Interviews
at School No.9

				First Interview			Second Interview		
No	Code	Gender	Ages	1.1	1.2	1.3	2.1	2.2	2.3
1	901	F	12.67	1	1	1	1	1	1
2	902	F	12.33	1	1	1	1	1	1
3	903	M	12.17	1	1	1	1	1	1
4	904	F	11.83	1	1	0	1	0	1
5	905	F	11.67	1	1	1	.5	1	1
6	906	F	12.83	1	1	0	.5	0	0
7	907	M	11.92	1	1	1	.5	1	0
	Total			7	??	5	5.5	5	5

Note

Code	Question
1.1	What causes night and day (explain verbally)
1.2	Showing how the earth rotates (with the body)
1.3	How the eclipse occurred (explain verbally)
2.1	Identify four cardinal directions (with the flat map and the globe)
2.2	Showing how the earth rotates (with the globe)
2.3	How the eclipse occurred (showing with the eclipse model)

Table 19

Students' Performance During Two Interviews
at School No.10

				First Interview			Second Interview		
No	Code	Gender	Ages	1.1	1.2	1.3	2.1	2.2	2.3
1	1001	F	12.00	1	0	1	.5	1	1
2	1002	M	12.33	1	1	0	0	1	1
3	1003	F	12.75	1	1	1	0	0	1
4	1004	F	12.33	1	1	0	0	0	0
5	1005	F	12.83	1	0	1	.5	1	1
6	1006	M	11.58	1	1	1	.5	1	1
7	1007	F	13.00	1	1	1	.5	1	1
	Total			7	5	6	2	6	5

Note

Code	Question
1.1	What causes night and day (explain verbally)
1.2	Showing how the earth rotates (with the body)
1.3	How the eclipse occurred (explain verbally)
2.1	Identify four cardinal directions (with the flat map and the globe)
2.2	Showing how the earth rotates (with the globe)
2.3	How the eclipse occurred (showing with the eclipse model)

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